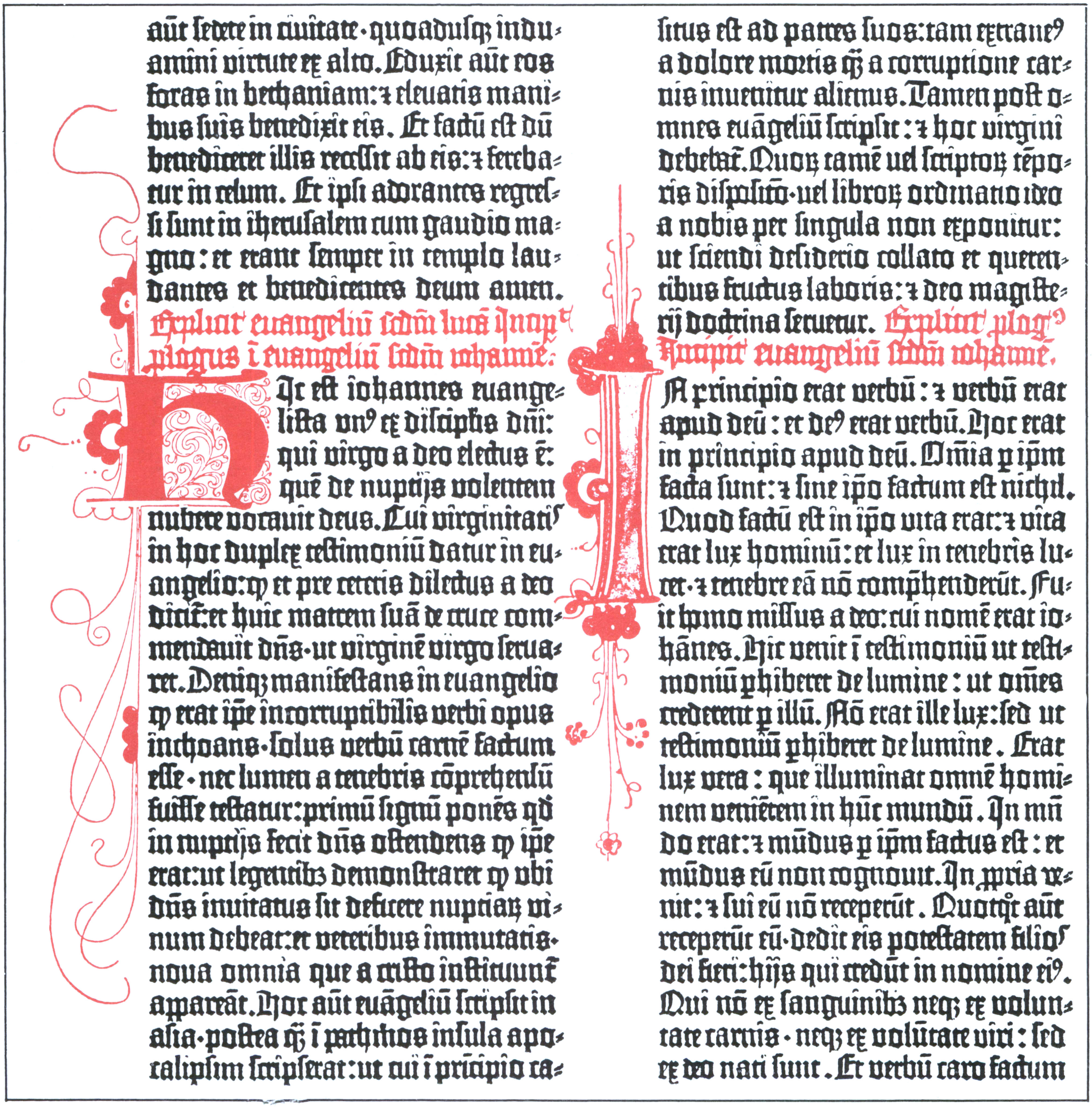
creative computing

the magazine of recreational and educational computing
vol 2, no 2
Mar-Apr 1976
$1.50

ARTIFICIAL INTELLIGENCE & EXTRATERRESTRIAL INTELLIGENCE

Can Computers Think?



aūt ſedete in ciuitate · quoadusq; induamini virtute ex alto. Eduxit aūt eos foras in bethaniam: ⁊ eleuatis manibus ſuis benedixit eis. Et factū eſt dū benediceret illis receſſit ab eis: ⁊ ferebatur in celum. Et ipſi adorantes regreſſi ſunt in iheruſalem cum gaudio magno: et erant ſemper in templo laudantes et benedicentes deum amen.

Explicit euangeliū ſcdm̄ lucā ĩncipit ꝓlogus ĩ euangeliū ſcdm̄ iohannē:

Hic eſt iohannes euangeliſta un⁹ ex diſcipulis dñi: qui virgo a deo electus ē: quē de nupcijs volentem nubere vocauit deus. Cui virginitatis in hoc duplex teſtimoniū datur in euangelio: q̄ et pre ceteris dilectus a deo dicit: et huic matrem ſuā de cruce commendauit dñs · ut virginē virgo ſeruaret. Deniq; manifeſtans in euangelio q̄ erat ipſe incorruptibilis verbi opus inchoans · ſolus verbū carnē factum eſſe · nec lumen a tenebris cōprehenſū fuiſſe teſtatur: primū ſignū ponēs qd̄ in nupcijs fecit dñs oſtendens q̄ ipſe erat: ut legentibz demonſtraret q̄ ubi dñs inuitatus ſit deficere nuptiaꝝ vinum debeat: et veteribus immutatis · noua omnia que a criſto inſtituunt appareāt. Hoc aūt euāgeliū ſcripſit in aſia · poſtea q̄ī ī pathmos inſula apocalipſim ſcripſerat: ut cui ī principio ca-

ſitus eſt ad patres ſuos: tam extrane⁹ a dolore mortis q̄ a corruptione carnis inuenitur alienus. Tamen poſt omnes euāgeliū ſcripſit: ⁊ hoc virgini debebatur. Quoꝝ tamē vel ſcriptoꝝ tēporis diſpoſitio · vel libroꝝ ordinatio ideo a nobis per ſingula non exponitur: ut ſciendi deſiderio collato et querentibus fructus laboris: ⁊ deo magiſterij doctrina ſeruetur. Explicit plog⁹ Incipit euangeliū ſcdm̄ iohannē.

In principio erat verbū: ⁊ verbū erat apud deū: et de⁹ erat verbū. Hoc erat in principio apud deū. Omīa ꝑ ipm̄ facta ſunt: ⁊ ſine ipō factum eſt nichil. Quod factū eſt in ipō vita erat: ⁊ vita erat lux hominū: et lux in tenebris lucet · ⁊ tenebre eā nō cōphenderūt. Fuit homo miſſus a deo: cui nomē erat iohānes. Hic venit ī teſtimoniū ut teſtimoniū ꝓhiberet de lumine: ut omēs crederent ꝑ illū. Nō erat ille lux: ſed ut teſtimoniū ꝓhiberet de lumine. Erat lux vera: que illuminat omnē hominem veniētem in hūc mundū. In mūdo erat: ⁊ mūdus ꝑ ipm̄ factus eſt: et mūdus eū non cognouit. In ꝓpria venit: ⁊ ſui eū nō receperūt. Quotquot aūt receperūt eū · dedit eis poteſtatem filios dei fieri: hijs qui credūt in nomine ei⁹. Qui nō ex ſanguinibz neq; ex voluntate carnis · neq; ex volūtate viri: ſed ex deo nati ſunt. Et verbū caro factum

Asimov: The Cosmic Subway Line

Dickson: Computers Don't Argue

THE FUTURE OF COMPUTERS

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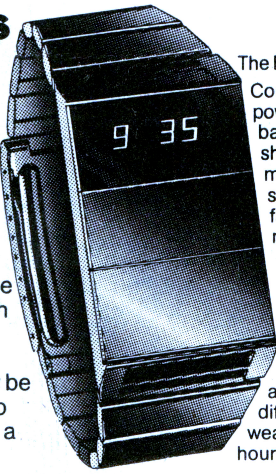

★practical–easily built by anyone in an evening's straightforward assembly.

★complete–right down to strap and batteries.

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a) reference oscillator
b) divider chain
c) decoder circuits
d) display inhibit circuits
e) display driving circuits.

The chip is totally designed and manufactured in the UK, and is the first design to incorporate *all* circuitry for a digital watch on a single chip.

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3. encapsulated quartz crystal
4. trimmer
5. capacitor
6. LED display
7. 2-part case with window in position
8. batteries
9. battery-clip
10. black strap (black stainless-steel bracelet optional extra–see order form)
11. full instructions for building and use.

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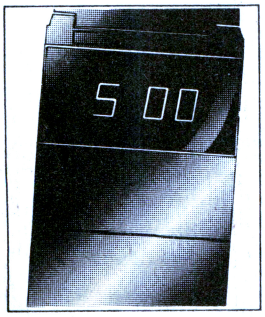
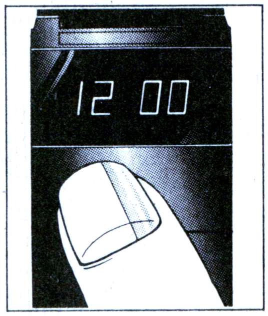
The special features of The Black Watch

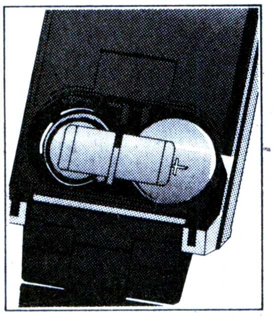
Smooth, chunky, matt-black case, with black strap. (Black stainless-steel bracelet available as extra–see order form.)

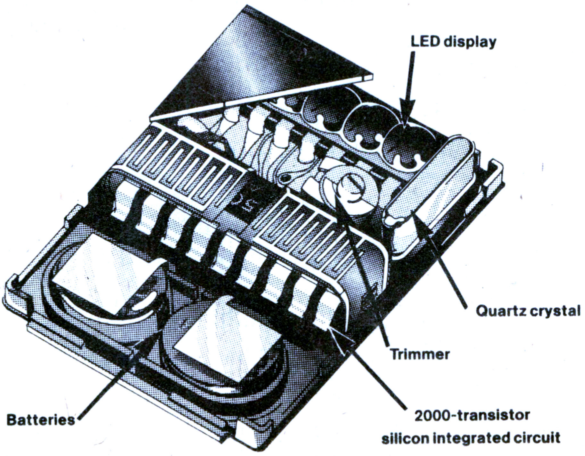


Large, bright, red display–easily read at night. Touch-and-see case–no unprofessional buttons.



Runs on two hearing-aid batteries (supplied). Change your batteries yourself–no expensive jeweller's service.





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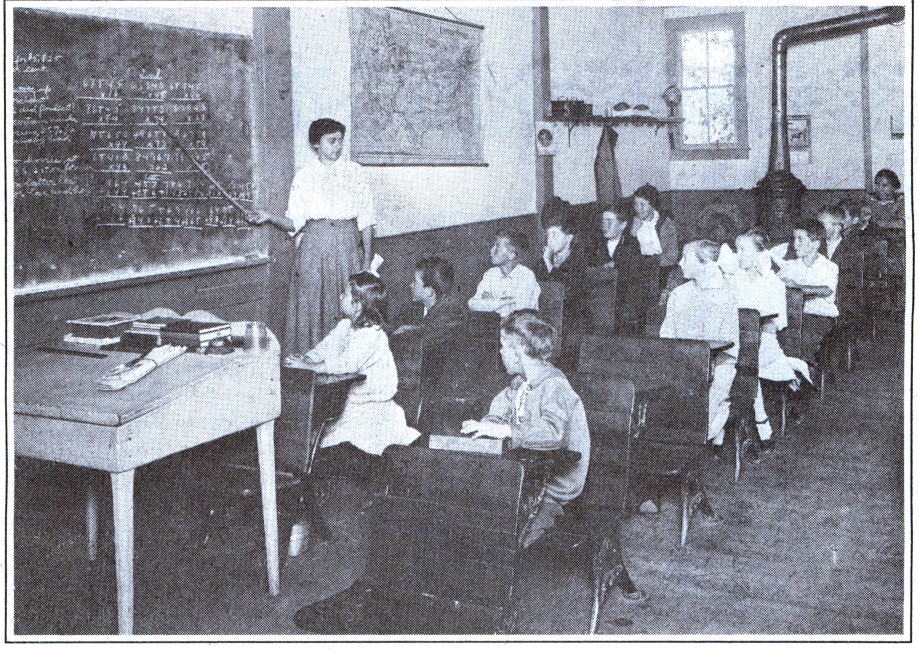

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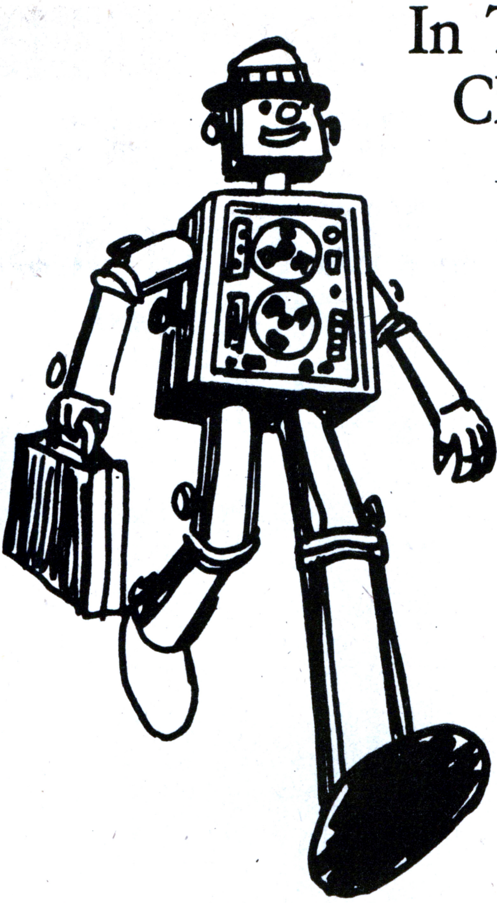

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Apr-May 1976

Volume 2 Number 2

Consecutive
issue no. 8

CREATIVE COMPUTING is published bi-monthly by Ideametrics. Address for subscriptions and correspondence: P.O. Box 789-M, Morristown, NJ 07960. Editorial office: 20 Lynnfield Drive, Morristown, NJ 07960.

Subscriptions: Institutional 1-year $15, 3-year $40; Individual 1-year $8, 3-year $21; Student 1-year $6, 3-year $16; Foreign 1-year $10, 3-year $27. Subscription orders, change of address, Form 3579 to CREATIVE COMPUTING, P.O. Box 789-M, Morristown, NJ 07960.

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THE COVER

The cover is a portion of a page from the first book, the Bible, printed with movable type. It took nearly 400 years for this invention of Johann Gutenberg in 1440 to be used widely throughout the world. Computer usage seems to be following a similar growth pattern to printing, although greatly accelerated, as it infiltrates into every nook and cranny of society and the world. (Also see page 9)

THE BEST OF CREATIVE COMPUTING

In this 328-page book are all the articles, stories, learning activities, games, and puzzles that appeared in *Creative Computing* Volume 1, Numbers 1 through 6. The contents cover the gamut of computer applications in education and recreation. Over 200 contributors are represented from college professor to high school student, from U.S. Senator to underground cartoonist and from corporation president to science fiction author.

The book is 8½ x 11, printed on high-quality paper with 3-color cover. Price in USA $8.95 plus 75¢ shipping ($9.70 total). Outside USA, shipping is $1.75 ($10.70 total). Please enclose payment—on billed orders we add $1.00 billing charge. Creative Computing Press, P.O. Box 789-M, Morristown, NJ 07960, USA. (We welcome bookstore and dealer inquiries.)

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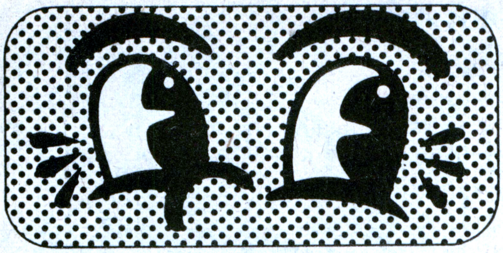
Return form to: CREATIVE COMPUTING, P.O. Box 789-M, Morristown, N.J. 07960, USA



Notices, etc.

More important notices on pages 9 and 86.

STAR TREK INFORMATION EXCHANGE

Ever since *Creative Computing* published the article on Star Trek and the listing of the Super Star Trek Game by Bob Leedom, I have been swamped with letters from readers suggesting that they or we operate a Star Trek information exchange. I've also gotten many letters from readers that have a version of Star Trek in FORTRAN or APL or different version of BASIC offering to exchange it, sell it, or give it away to other readers. Consequently, starting with the September-October issue, *Creative Computing* will run a column of names, addresses, and other information pertaining to Star Trek material that readers might wish to exchange with one another.

We'll list material both free, exchange, and for sale. (On material for sale I'll put an upper limit of $20.00 on anything we list. Anything costing more than $20.00 I feel is in the area of a profit-making activity and these things can well afford to purchase an ad in *Creative Computing*. A 1-column inch ad costs only $25.00). In this column I'm not looking for material that the other Star Trek fanzines would cover but rather only computer-related Star Trek material. This would be programs, computer drawings of Mr. Spock and the other Star Trek characters, and other related material. Deadline for material to appear in the September-October issue is June 15th. — DHA

TWO CREATIVE COMPUTING BOOKS

The Best of Creative Computing — Volume 1	$8.95
Artist and Computer (Edited by Ruth Leavitt)	$6.95

NATIONAL STUDENT COMPUTER FAIR NEWS

Hurry! April 1, 1976 is the last day to get in entries. Eight entry categories—lots of winners! Open to students in Grades K-12. **First prize is an Altair 8800 Computer Kit.** Eight second prizes of $100 savings bonds and sixteen honorable mentions of $25 savings bonds. All winners get subscriptions to *Creative Computing* too.

SPONSORS

American AT&T
Burroughs Corporation
The City University of N.Y.
Creative Computing
Educomp Corporation
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Teachers College, Columbia Univ.
Wang Laboratories

FOR ENTRY FORM

1976 National Student Computer Fair, CUNY,
33 West 42nd Street, New York, NY 10036.

YOUR OWN COMPUTER IMAGE

Big 10″ x 12″ computer image will be produced from any size full face photo. $4.00 postpaid.

Computer Hut (4), 7702 Richmond Highway, Alexandria, VA 22306.

OUR FACE IS RED DEPARTMENT

I goofed. In "The Computer Glass Box" by Howard Peelle, *Creative Computing*, Jan-Feb 1976, pages 36 and 37 were interchanged. For the article to make sense, you should read pg. 35, 37, 36, 38, 39. Also, we should have noted that the article was a slight modification of one which appeared originally in *Educational Technology*. Sorry — DHA.

HAPPY BIRTHDAY TO US

For those of you interested in such things, this issue is the second issue of the second year (Volume 2) of *Creative Computing*. We promised you six issues per year and, contrary to the experience of many of my friends publishing "small" magazines, we delivered six issues. I won't review the endless trials, tribulations, and pains of publishing the zine, however, I should mention that balancing the problems were many moments of sheer exhileration, challenge, and fulfillment.

We've gone from 48 pages in Issues 1 and 2 to an average of 76 pages over the last four issues, a healthy growth. We've gone from being deeply in the red to being much less deeply in the red. The staff now consists of me (using all the time I can spare from my regular job at AT&T), Carol Tick (full time Business Manager/Secretary), Josie Task (half time Managing Editor), and other people on an occasional voluntary basis.

We recently switched typesetters (twice!) and are now being set on a computerized system operated by Benway, Maxwell, & Smith in Chatham, N.J. Our subscription list maintenance is subcontracted to Automatic Fulfillment in Dover, N.J. who use a semi-computerized system. Most of the layout and graphics are done by me. Printing is by Redmond Press in Denville, N.J. and binding and trimming by C&G Finishing also in Denville. The most unreliable portion of the chain, delivery, is handled by our friends, the U.S. Postal Service. However, it should improve somewhat now that we have a second-class permit.

We distributed about 50,000 subscription flyers in the first year and 20,000 spirit duplicating flyers. We distributed17,500 free copies of the magazine, mostly of Issues 1 and 2; we sold an additional 4000 single copies. We got editorial writeups or mention in 62 other magazines and ran subscription ads in 16 other zines.

By the end of the first year we had something over 6500 paid subscribers and another 1400 or so single copy sales of the last issue. New subscriptions were (and are) increasing at the rate of 150 plus per week; however, I do not have a good fix on renewal rate at this point.

All in all it's been a whale of an experience and I'm looking forward to another year of "fun!" — DHA

CREATIVE COMPUTING Editorial

Non-Human Intelligence

Pushing into the future it is inevitable that we humans will be confronted with a much more challenging array of choices, problems, and technology than we have today. Not only that, but we will very likely be confronted with additional types of intelligences—from machines that we ourselves build to extraterrestrial intelligent beings. It is appropriate, therefore, that this issue of CREATIVE COMPUTING examine both artificial (machine) intelligence and also extraterrestrial intelligence. (Other than the name, they bear no relationship to each other.)

Somehow it seems appropriate that it is the computer that is helping us to leap ahead in our quest to seek out extraterrestrial intelligence. It was a computer aided prediction, for example, that recently helped S. Christian Simonson of the University of Maryland identify the closest galaxy to the milky way. It's ironic that astromers have identified thousands of distant galaxies and galaxy clusters up to 350 million light-years away, yet the light from our own milky way obscured our nearest neighbor, a small galaxy only 55,000 light-years distant.

The largest-scale project seeking life on other worlds is CETI (Communicating With Extraterrestrial Intelligence) sponsored by the Soviet Academy of Science. There's no telling what frequency an alien civilization might use to broadcast so listening will be done over the entire shortwave portion of the radio astronomy frequency range (1 to 100 gigahertz). The project will last from 1975 to 1990 and will use three kinds of search. The first will check each star within 100 light-years of the sun, and possibly if time permits, out to 1,000 light-years. The second will examine different galaxies in the local cluster. Finally, there will be an all-sky survey for signals from anywhere.

Turning to more distant observations, consider for a moment the light from the Coma galaxy cluster that has taken 350 million years to reach us. In other words, we are now observing that cluster as it was 350 million years ago. Conversely, if an observer on a planet in the Coma cluster had a telescope pointed towards the milky way, he would be seeing it as it was 350 million years ago, eons before the earth that we know today. But 350 million light-years is nothing; the Arecibo radio telescope has recorded signals from quasars more than 7,000 million light-years away, that are receding away from us with velocities of more than 150,000 miles per second. From these observations and the relation between the distance and the speed of recession, we can calculate how long ago all the matter of the universe was concentrated in one, immense, incredibly dense mass. The answer is about 10,000 million years ago.

Mind boggling, isn't it, that our observation of quasars today takes us back three-quarters of the time to the beginning of the universe? But if we can observe objects three-quarters of the way back to the beginning of the universe, why not go further? And quite accidentally that has happened. Bell Labs, in testing new ultra sensitive radio receiving equipment working at wave length of 7 cm., found radio noise 100 times stronger than the expected noise level of the equipment. More recent tests in a rocket and high altitude balloon confirmed this radiation. This noise, in fact, is the emission from the original primeral fireball of the universe. Talk about a big bang!

Perhaps we can't **travel** back in time but we can **look** back. Way back! The next time you gaze up at the stars, why not ponder some of these questions. Was there space in which the embryonic universe existed? How and why did the universe fly outward? (The dense concentrations of matter that existed at the beginning of the universe are similar to those existing in a black hole from which nothing can escape.) Will the universe expand forever? Or will it again collapse to a mass of infinite density? Is there a mirror universe composed of anti-matter which is contracting as our universe of matter expands? And what is the position of humankind in this vast scheme?

David H. Ahl

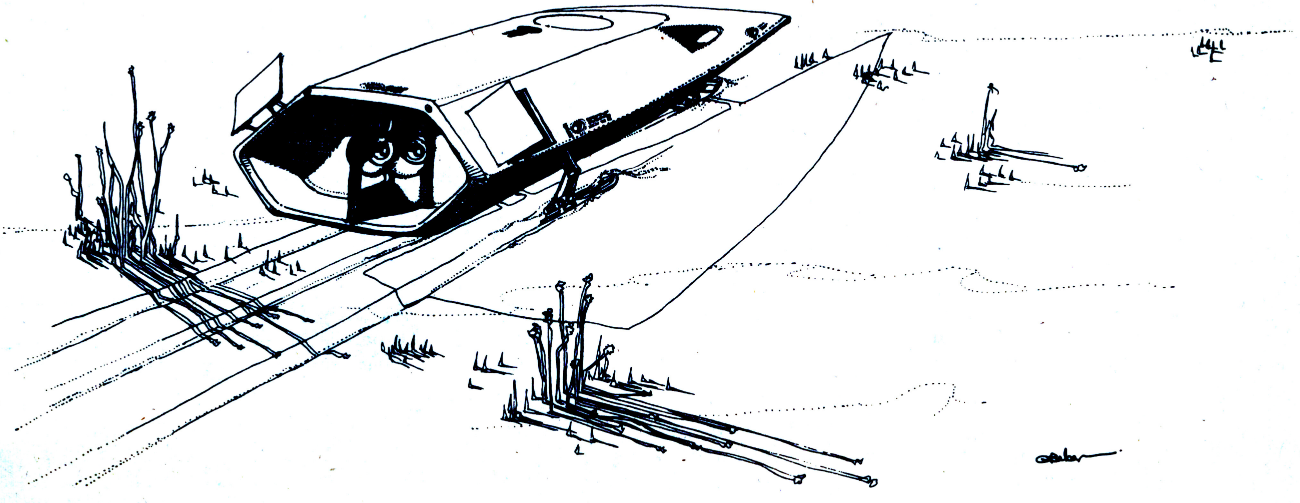


Illustration by George Beker

THE MAGIC OF ELECTRONIC FUNDS TRANSFER
OR
THE LITTLE GUY TAKES IT IN THE EAR (AGAIN)
OR
WHY FOREIGN SUBSCRIBERS MUST NOW SEND CASH

by David Ahl

It all started innocently enough one day when I received four French checks back from the bank (Morris County Savings) full of staples, folds, and mutilations. Accompanying them was a teller's slip with the cryptic notation, "not cashed due to change in foreign exchange regulations."

Okay, set them aside and remember to inquire about them next time I'm in the bank.

Next day, I receive another slip from the bank *charging* my account $31.84, again with a cryptic notation on the teller's slip, "charged to your account by Manufacturer's Hanover Trust Company." Strange, I thought, since I'd never gone there in my life.

I decided a visit to the bank was in order, even though I normally avoid it like the plague (just can't stand long lines and well-meaning-but-not-very-bright tellers).

Decided to see an officer. Did you know that the "officers" sitting in the open area where you open new accounts and redeem bonds and get your signature approved et al are really just pseudo officers? After two of them huddled for about 15 minutes, one left to check the account "on the computer," some more discussion and then this woman pseudo officer announced, "Manufacturer's Hanover charged your account for cashing four foreign checks."

"But they *didn't* cash them," said I. "Here they are."

"Well then they charged you for processing them."

"By processing, you mean returning them uncashed" I said, trying to keep emotion from creeping into my voice.

"I guess you'll have to take it up with Manufacturer's Hanover," she said, cleverly trying to pass me out the door.

"But they aren't my bank, you are!" I said, allowing my emotion somewhat more open rein. The discussion continued in an inconclusive but gradually loudening manner, when she hastily excused herself. She returned in 10 minutes with a large man. I had visions of being escorted out the door but he showed me into a big office in the back. If not a real officer, he was less pseudo than the ones in front.

He explained that First National City Bank and Manufacturers Hanover were Morris County's foreign correspondent banks. There was another link through Heritage-Iron Bank but I never did understand that one. Anyway, the correspondent banks had announced that they were instituting a wonderful new computerized Electronic Funds Transfer System and they were doing away with time-consuming, messy, paper transactions and doing everything by electronic wire transmission. The announcements added that the cost per transaction was only $7.96 (M-H) and $9.26 (FNCB). This compares to $1.50 per check in the "old-fashioned" paper way. The announcement also said that regretfully, personal accounts could not be handled at this point.

In short, what had happened to our account was this: we received 4 subscription checks from France (total value $38.00). They were sent for collection to M-H who charged $7.96 ea. or $31.84. They were not collected (personal checks) but we were still charged. The officer promised to "look into the situation."

That was six weeks ago. A call yesterday indicated that Manufacturer's Hanover finally replied to the effect that they incurred the cost and it was up to us to pay (even though no service was performed).

I also inquired whether the use of cash had been outlawed yet and they allowed that it was still OK. Hence, instead of adding $8.00 or $9.00 to foreign subscriptions, we are suggesting that foreign subscribers pay for subscriptions *in U.S. currency.* Yes, I know that sending cash through the mail is "dangerous" but I either (1) have to open a foreign bank account in every country in which we do business or (2) add $8 or $9 to foreign subscriptions or (3) risk mail theft. Frankly, the last seems the most sensible alternative.

(We can still handle checks from Canada, but I suspect that won't last long).

The recent postal rate increase, has also forced a slight adjustment in foreign subscription rates. Also, no more foreign student subscriptions—one rate for all.

Foreign Subscription Rates:

1 Year	3 Years
$10.00	$27.00

10.000.000
6%
5
CAISSE
1

Poems by Esther Gloe

SYSTEM DESIGN

Read the numbers
Displayed on
The nixies.

To understand either
The programs or
The computer,
Study the manual.

It shows that fifty
Has been a valid number
In the system
For some time now,
But that one
Is never used in
An instruction.

It is a gate opener
Like zero.
A one in an instruction
Will mis-route power
And cause malfunction.

SURVIVAL

Darwin left something out of
His discussion of the
Survival of the fittest.

The dancing peacock,
The wild horse running,
All the proud eagles,
Were not included,
And they survived.

The poetry of motion,
The wings that beat slowly,
The hooves that tread
Softly, are not
For combat. They are merely
What everyone loves.

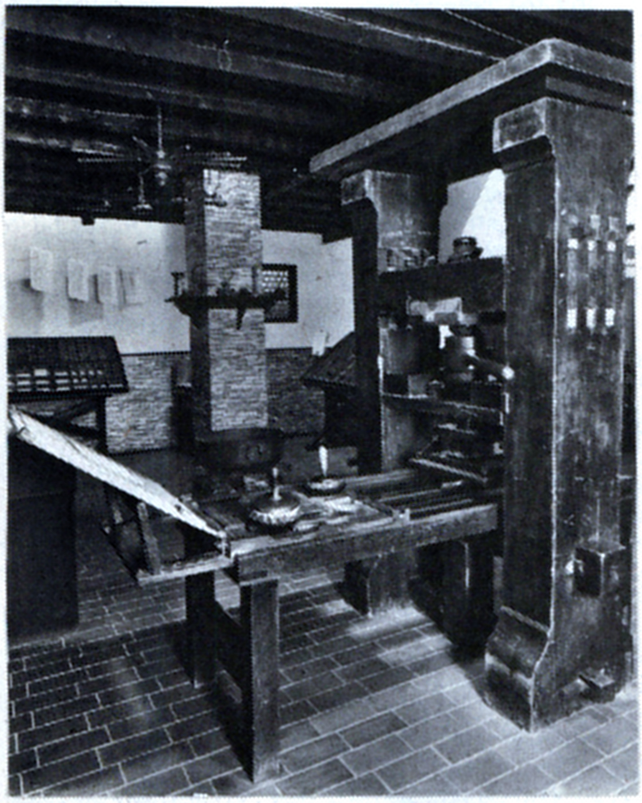
CQ

All the radio waves
Ever generated
Are still bouncing around
Out there in the sky.

Knocking off clouds
And the Van Allen Belt
Into receiving sets,
They become static.

Old Jack Benny shows,
Police calls, and
Front line messages
From World War Two
Grow distorted and
Weaken.

Someone
Could pick them up,
If he had a good
Receiver
And the antenna was
Pointed right.



GUTENBERG PRESS

The original Gutenberg printing press is housed in the Gutenberg Museum in Mainz, Germany. A companion press to the original is still used today to print single souvenir pages of Gutenberg's first Bible, one of which I obtained on a trip to Mainz last fall. The page is magnificent measuring 11" x 14" with printing in black and red, and decorative work in blue, gold, and red. (Unfortunately, the cover reproduction doesn't do it justice.) — DHA

AMATEUR COMPUTER FESTIVAL

A convention of amateur computer hobbyists will be held on Sunday, May 2, 1976, 10 am, Armstrong Hall, Trenton State College, Route 31. It will include a meeting of amateur computer clubs, technical talks, demonstrations, program duplication service, manufacturers booths, mini-seminars, and a flea market for swapping and selling components among amateurs ($2.00/spot). Expected attendance over 1,000. For more information: Dr. Allen Kent, Trenton State College, Trenton, NJ 08625. Tel: (609) 771-2487 days, (609) 443-3184 eves.

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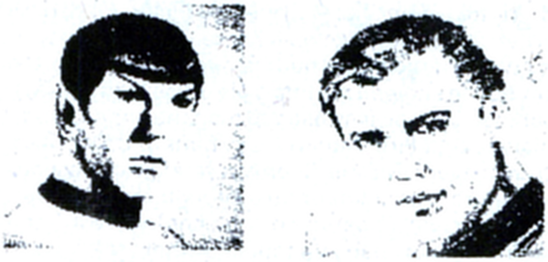

STAR TREK PEOPLE

Six computer images of your favorite Star Trek people: Kirk, Spock, McCoy, Scott, Chekov, Uhrura. Heavy poster stock, 8½ x 11. $2.50 per set postpaid. *Creative Computing*, P.O. Box 789-M, Morristown, N.J. 07960.

MR. SPOCK COMPUTER IMAGE

Dramatic large (17" x 23") computer image of Mr. Spock on heavy poster stock. Similar to the centerfold of May-Jun 1975 *Creative Computing* but larger with more detail. $1.00 each plus 50¢ postage and handling per order (of any quantity). Comes in a strong mailing tube. *Creative Computing*, P.O. Box 789-M, Morristown, NJ 07960.

Star-Times Gazette, 18 April 1997:

Nebula High School Illiteracy Scandal

The Nebula High School Board of Education is in the hot spot again as angry parents are reacting to results of a recently published four-year study of NHS graduates. The study was run by Educatron, a highly esteemed non-profit educational research firm, as part of a larger state-wide, state-sponsored study. The report showed that over 30% of the graduates of NHS in the past four years may be characterized as functional illiterates since they were unable either to program in even the most basic grade-school computer language, or to accurately interact with an on-line service such as the state's employment data base or the telephone company's encyclopaedic information center data base. Another 30% of the sample were skilled in only one of these areas, and a shocking 18% of the graduates did not know how to use the #HELP key on the telephone computer matrix overlay to ask for human assistance.

The 1990 Uniform State Education Standards adopted by the Interstate Education Conference of that year established this programming capability and public data base query skills as part of the standard basic skills package to be achieved by every student graduating from an accredited high school after 1995. Parents are anxious not only that their children are not receiving a minimum basic education, but also that the school's accreditation might be questioned or removed by the state on the basis of the Educatron report. Until the study results were published, Nebula H.S. was thought to be among the better schools in the metropolitan area.

Star-Times Gazette, 18 April 1997:

Display Option: Advertising, household.

!!!HOUSEBUG SALE NOW ON!!!

Replace your old grassclippers and dusteaters now while savings are at their best. Admit it. The microcircuits in your old grassclipper have had a good workout clipping a few blades at a time in that beautiful lawn of yours for the past three or four years. Send your old grassclipper out to pasture and replace it with the latest model. Cosmetic options available to replace that old clipper with a cheerful robin, cardinal, bluebird, or NEW, THIS YEAR, a SQUIRREL. Buy now and save credits!

Old dusteater looking dusteaten? Spends more and more time plugged into the wall socket to recharge? That means it spends less and less time scurrying around and disposing of dust and grit. Replace it now and save credits. New models include Calico Cat, Persian Cat, and Dusty the Dog.

Special savings to indoor/outdoor purchasers! Buy both a Dusteater and a Grassclipper and save an additional 5% off the total price. Watch your credits and your centimes will take care of themselves.

For display, price, and ordering dial HOUSEBUGS, INC. at &HOUSEBUG.

Star-Times Gazette, 18 April 1997:

Publication and Subscription Info

The *Star-Times Gazette* is maintained on a twenty-four hour cycle and is updated on an hourly basis. Editorial and news offices and Phonefax and Phonedisplay center are in the Vidinews Building, Washington Street, Metropolis.

Through partial subsidy by Government grant for Opportunity Equalization for the Underprivileged, the *Star-Times Gazette* is also printed in paper editions on Monday, Wednesday, Friday, and Sunday. Subscribers for paper editions must be certified as opportunity underprivileged (unable to maintain a home terminal) by their local Government Opportunity Equalization office.

Single news access is available through commercial scan stations. Regular subscribers may choose Phonefax or Phonedisplay service. Phonefax subscribers may select single-edition service or single-edition with single, double, or triple update options (six-hour basis) on any Vidinews approved hard-copy terminal. Phonedisplay service subscribers may choose single-scan, triple-scan, or unlimited-scan option access through any Vidinews approved display terminal.

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Government/Politics Package. Options: comprehensive, metropolitan, state or region, national, international.
Education News, Activities, and Games.
Finance.
Leisure Activities Schedules/Instructions.
Homemaking. Options: total, without advertising.
Fashion. Options: total, without advertising.
Advertising. Options: classified, classified (only one category), fashion, household, transportation.
Employment Opportunities. Options: all or one category.
Sports Schedules and Results. Options: comprehensive, by region, or by sport.

For subscription rates according to subscriber terminal type, communications line speed, and options, dial #VIDISUB and follow the instructions.

If you are reading this on "newspaper" and would like to receive the *Star-Times Gazette* on paper, see your Government Opportunity Equalization office for non-terminal certification and Postfax the certification and application form you will receive to the *Star-Times Gazette*, Postfax %ViDiSuBs.

This page of features from the 1997 *Star Times Gazette* was compiled by Deanna J. Dragunas of the Dept. of Defense Computer Institute, Washington, D.C.

COMPUTERS DON'T ARGUE

Gordon R. Dickson

A computer
is the Ultimate Bigot.
Since it's absolutely and
totally lacking in
imagination,
it can't possibly imagine
that it could be wrong!
Or, of course, that
another computer could
be wrong ...

Treasure Book Club
PLEASE DO NOT FOLD,
SPINDLE OR MUTILATE
THIS CARD
Mr: Walter A. Child Balance: $4.98
Dear Customer: Enclosed is your latest book selection. "Kidnapped," by Robert Louis Stevenson.

Woodlawn Drive
Panduk, Michigan
Nov. 16, 1965

Treasure Book Club
1823 Mandy Street
Chicago, Illinois

Dear Sirs:

I wrote you recently about the computer punch card you sent, billing me for "Kim," by Rudyard Kipling. I did not open the package containing it until I had already mailed you my check for the amount on the card. On opening the package, I found the book missing half its pages. I sent it back to you, requesting either another copy or my money back. Instead, you have sent me a copy of "Kidnapped," by Robert Louis Stevenson. Will you please straighten this out?

I hereby return the copy of "Kidnapped."

Sincerely yours,
Walter R. Child

Treasure Book Club
SECOND NOTICE
PLEASE DO NOT FOLD,
SPINDLE OR MUTILATE
THIS CARD
Mr: Walter A. Child Balance: $4.98
For "Kidnapped," by Robert Louis Stevenson
(If remittance has been made for the above, please disregard this notice)

437 Woodlawn Drive
Panduk, Michigan
Jan. 21, 1966

Treasure Book Club
1823 Mandy Street
Chicago, Illinois

Dear Sirs:

May I direct your attention to my letter of November 16, 1965? You are still continuing to dun me with computer punch cards for a book I did not order. Whereas, actually, it is your company that owes *me* money.

Sincerely yours,
Walter A. Child

Courtesy *Analog,* Copyright 1965 by The Conde Nast Publications, Inc. Reprinted by permission of the author. Illustration by John Schoenherr.

Treasure Book Club
1823 Mandy Street
Chicago, Illinois
Feb. 1, 1966

Mr. Walter A. Child
437 Woodlawn Drive
Panduk, Michigan

Dear Mr. Child:

We have sent you a number of reminders concerning an amount owing to us as a result of book purchases you have made from us. This amount, which is $4.98 is now long overdue.

This situation is disappointing to us, particularly since there was no hesitation on our part in extending you credit at the time original arrangements for these purchases were made by you. If we do not receive payment in full by return mail, we will be forced to turn the matter over to a collection agency.

Very truly yours,
Samuel P. Grimes
Collection Mgr.

---

437 Woodlawn Drive
Panduk, Michigan
Feb. 5, 1966

Dear Mr. Grimes:

Will you stop sending me punch cards and form letters and make me some kind of a direct answer from a human being?

I don't owe you money. *You* owe me money. Maybe I should turn your company over to a collection agency.

Walter A. Child

FEDERAL COLLECTION OUTFIT
88 Prince Street
Chicago, Illinois
Feb. 28, 1966

Mr. Walter A. Child
437 Woodlawn Drive
Panduk, Michigan

Dear Mr. Child:

Your account with the Treasure Book Club, of $4.98 plus interest and charges has been turned over to our agency for collection. The amount due is now $6.83. Please send your check for this amount or we shall be forced to take immediate action.

Jacob N. Harshe
Vice President

FEDERAL COLLECTION OUTFIT
88 Prince Street
Chicago, Illinois
April 8, 1966

Mr. Walter A. Child
437 Woodlawn Drive
Panduk, Michigan

Dear Mr. Child:

You have seen fit to ignore our courteous requests to settle your long overdue account with Treasure Book Club, which is now, with accumulated interest and charges, in the amount of $7.51.

If payment in full is not forthcoming by April 11, 1966 we will be forced to turn the matter over to our attorneys for immediate court action.

Ezekiel B. Harshe
President

MALONEY, MAHONEY, MACNAMARA and PRUIT
Attorneys
89 Prince Street
Chicago, Illinois
April 29, 1966

Mr. Walter A. Child
437 Woodlawn Drive
Panduk, Michigan

Dear Mr. Child:

Your indebtedness to the Treasure Book Club has been referred to us for legal action to collect.

This indebtedness is now in the amount of $10.01. If you will send us this amount so that we may receive it before May 5, 1966, the matter may be satisfied. However, if we do not receive satisfaction in full by that date, we will take steps to collect through the courts.

I am sure you will see the advantage of avoiding a judgment against you, which as a matter of record would do lasting harm to your credit rating.

Very truly yours,
Hagthorpe M. Pruitt Jr.
Attorney at law

---

437 Woodlawn Drive
Panduk, Michigan
May 4, 1966

Mr. Hagthorpe M. Pruitt, Jr.
Maloney, Mahoney, MacNamara and Pruitt
89 Prince Street
Chicago, Illinois

Dear Mr. Pruitt:

You don't know what a pleasure it is to me in this matter to get a letter from a live human being to whom I can explain the situation.

This whole matter is silly. I explained it fully in my letters to the Treasure Book Company. But I might as well have been trying to explain to the computer that puts out their punch cards, for all the good it seemed to do. Briefly, what happened was I ordered a copy of "Kim," by Rudyard Kipling, for $4.98. When I opened the package they sent me, I found the book had only half its pages, but I'd previously mailed a check to pay them for the book.

I sent the book back to them, asking either for a whole copy or my money back. Instead, they sent me a copy of "Kidnapped," by Robert Louis Stevenson—which I had not ordered; and for which they have been trying to collect from me.

Meanwhile, I am still waiting for the money back that they owe me for the copy of "Kim" that I didn't get. That's the whole story. Maybe you can help me straighten them out.

Relievedly yours,
Walter A. Child

P.S.: I also sent them back their copy of "Kidnapped," as soon as I got it, but it hasn't seemed to help. They have never even acknowledged getting it back.

MALONEY, MAHONEY, MACNAMARA and PRUITT
Attorneys
89 Prince Street
Chicago, Illinois
May 9, 1966

Mr. Walter A. Child
437 Woodlawn Drive
Panduk, Michigan

Dear Mr. Child:

I am in possession of no information indicating that any item purchased by you from the Treasure Book Club has been returned.

I would hardly think that, if the case had been as you stated, the Treasure Book Club would have retained us to collect the amount owing from you.

If I do not receive your payment in full within three days, by May 12, 1966, we will be forced to take legal action.

Very truly yours,
Hagthorpe M. Pruitt Jr.

COURT OF MINOR CLAIMS
Chicago, Illinois

Mr. Walter A. Child:
437 Woodlawn Drive,
Panduk, Michigan

Be informed that a judgment was taken and entered against you in this court this day of May 26, 1966 in the amount of $15.66 including court costs.

Payment in satisfaction of this judgment may be made to this court or to the adjudged creditor. In the case of payment being made to the creditor, a release should be obtained from the creditor and filed with this court in order to free you of legal obligation in connection with this judgment.

Under the recent Reciprocal Claims Act, if you are a citizen of a different state, a duplicate claim may be automatically entered and judged against you in your own state so that collection may be made there as well as in the State of Illinois.

COURT OF MINOR CLAIMS
Chicago, Illinois
PLEASE DO NOT FOLD,
SPINDLE OR MUTILATE
THIS CARD

Judgment was passed this day of May 27, 1966, under Statute $15.66

Against: Child, Walter A. of 347 Woodlawn Drive, Panduk, Michigan. Pray to enter a duplicate claim for judgment

In: Picayune Court—Panduk, Michigan

For Amount: Statute 941

---

437 Woodlawn Drive
Panduk, Michigan
May 31, 1966

Samuel P. Grimes
Vice President, Treasure Book Club
1823 Mandy Street
Chicago, Illinois

Grimes:

This business has gone far enough. I've got to come down to Chicago on business of my own tomorrow. I'll see you then and we'll get this straightened out once and for all, about who owes what to whom, and how much!

Yours,
Walter A. Child

From the desk of the Clerk
Picayune Court
June 1, 1966

Harry:

The attached computer card from Chicago's Minor Claims Court against A. Walter has a 1500-series Statute number on it. That puts it over in Criminal with you, rather than Civil, with me. So I herewith submit it for your computer instead of mine. How's business?

Joe

CRIMINAL RECORDS
Panduk, Michigan
PLEASE DO NOT FOLD,
SPINDLE OR MUTILATE
THIS CARD

Convicted: (Child) A. Walter
On: May 26, 1966
Address: 437 Woodlawn Drive, Panduk, Mich.
Crim: Statute: 1566 (Corrected) 1567
Crime: Kidnap
Date: Nov. 16, 1965
Notes: At large. To be picked up at once.

POLICE DEPARTMENT, PANDUK, MICHIGAN. TO POLICE DEPARTMENT CHICAGO ILLINOIS. CONVICTED SUBJECT A. (COMPLETE FIRST NAME UNKNOWN) WALTER, SOUGHT HERE IN CONNECTION REF. YOUR NOTIFICATION OF JUDGMENT FOR KIDNAP OF CHILD NAMED ROBERT LOUIS STEVENSON, ON NOV. 16, 1965. INFORMATION HERE INDICATES SUBJECT FLED HIS RESIDENCE, AT 437 WOODLAWN DRIVE, PANDUK, AND MAY BE AGAIN IN YOUR AREA.

POSSIBLE CONTACT IN YOUR AREA: THE TREASURE BOOK CLUB, 1823 MANDY STREET, CHICAGO, ILLINOIS. SUBJECT NOT KNOWN TO BE ARMED, BUT PRESUMED DANGEROUS. PICK UP AND HOLD, ADVISING US OF CAPTURE . . .

TO POLICE DEPARTMENT, PANDUK, MICHIGAN. REFERENCE YOUR REQUEST TO PICK UP AND HOLD A. (COMPLETE FIRST NAME UNKNOWN) WALTER, WANTED IN PANDUK ON STATUTE 1567, CRIME OF KIDNAPPING.

SUBJECT ARRESTED AT OFFICES OF TREASURE BOOK CLUB, OPERATING THERE UNDER ALIAS WALTER ANTHONY CHILD AND ATTEMPTING TO COLLECT $4.98 FROM ONE SAMUEL P. GRIMES, EMPLOYEE OF THAT COMPANY.

DISPOSAL: HOLDING FOR YOUR ADVICE.

POLICE DEPARTMENT PANDUK, MICHIGAN TO POLICE DEPARTMENT CHICAGO, ILLINOIS.

REF: A. WALTER (ALIAS WALTER ANTHONY CHILD) SUBJECT WANTED FOR CRIME OF KIDNAP, YOUR AREA, REF: YOUR COMPUTER PUNCH CARD NOTIFICATION OF JUDGMENT, DATED MAY 27, 1966. COPY OUR CRIMINAL RECORDS PUNCH CARD HEREWITH FORWARDED TO YOUR COMPUTER SECTION.

CRIMINAL RECORDS
Chicago, Illinois
PLEASE DO NOT FOLD,
SPINDLE OR MUTILATE
THIS CARD

SUBJECT (CORRECTION—OMITTED RECORD SUPPLIED)
APPLICABLE STATUTE NO. 1567
JUDGMENT NO. 456789
TRIAL RECORD: APPARENTLY MISFILED AND UNAVAILABLE
DIRECTION: TO APPEAR FOR SENTENCING BEFORE JUDGE JOHN ALEXANDER MCDIVOT, COURTROOM A JUNE 9, 1966

From the Desk of
Judge Alexander J. McDivot

June 2, 1966

Dear Tony:

I've got an adjudged criminal coming up before me for sentencing Thursday morning—but the trial transcript is apparently misfiled.

I need some kind of information (Ref: A. Walter—Judgment No. 456789, Criminal). For example, what about the victim of the kidnapping. Was victim harmed?

Jack McDivot

June 3, 1966

Records Search Unit
Re: Ref: Judgment No. 456789 —was victim harmed?

Tonio Malagasi
Records Division

June 3, 1966

To: United States Statistics Office
Attn.: Information Section
Subject: Robert Louis Stevenson
Query: Information concerning

Records Search Unit
Criminal Records Division
Police Department
Chicago, Ill.

June 5, 1966

To: Records Search Unit
Criminal Records Division
Police Department
Chicago, Illinois
Subject: Your query re Robert Louis Stevenson (File no. 189623)
Action: Subject deceased. Age at death, 44 yrs. Further information requested?

A. K.
Information Section
U. S. Statistics Office

June 6, 1966

To: United States Statistics Office
Attn.: Information Division
Subject: Re: File no. 189623

No further information required.

Thank you.
Records Search Unit
Criminal Records Division
Police Department
Chicago, Illinois

June 7, 1966

To: Tonio Malagasi
Records Division
Re: Ref: judgment No. 456789—victim is dead.

Records Search Unit

June 7, 1966

To: Judge Alexander J. McDivot's Chambers

Dear Jack:

Ref: Judgment No. 456789. The victim in this kidnap case was apparently slain.

From the strange lack of background information on the killer and his victim, as well as the victim's age, this smells to me like a gangland killing. This for your information. Don't quote me. It seems to me, though, that Stevenson—the victim—has a name that rings a faint bell with me. Possibly, one of the East Coast Mob, since the association comes back to me as something about pirates—possibly New York dockage hijackers—and something about buried loot.

As I say, above is only speculation for your private guidance..

Any time I can help . . .

Best,
Tony Malagasi
Records Division

MICHAEL R. REYNOLDS
Attorney-at-law
49 Water Street
Chicago, Illinois

June 8, 1966

Dear Tim:

Regrets: I can't make the fishing trip. I've been court-appointed here to represent a man about to be sentenced tomorrow on a kidnapping charge.

Ordinarily, I might have tried to beg off, and McDivot, who is doing the sentencing, would probably have turned me loose. But this is the damndest thing you ever heard of.

The man being sentenced has apparently been not only charged, but adjudged guilty as a result of a comedy of errors too long to go into here. He not only isn't guilty—he's got the best case I ever heard of for damages against one of the larger Book Clubs headquartered here in Chicago. And that's a case I wouldn't mind taking on.

It's inconceivable—but damnably possible, once you stop to think of it in this day and age of machine-made records—that a completely innocent man could be put in this position.

There shouldn't be much to it. I've asked to see McDivot tomorrow before the time for sentencing, and it'll just be a matter of explaining to him. Then I can discuss the damage suit with my freed client at his leisure.

Fishing next weekend?

Yours,
Mike

MICHAEL R. REYNOLDS
Attorney-at-law
49 Water Street
Chicago, Illinois

June 10

Dear Tim:

In haste—

No fishing this coming week either. Sorry.

You won't believe it. My innocent-as-a-lamb-and-I'm-not-kidding client has just been sentenced to death for first-degree murder in connection with the death of his kidnap victim.

Yes, I explained the whole thing to McDivot. And when he explained his situation to me, I nearly fell out of my chair.

It wasn't a matter of my not convincing him. It took less than three minutes to show him that my client should never have been within the walls of the County Jail for a second. But—get this—McDivot couldn't do a thing about it.

The point is, my man had already been judged guilty according to the computerized records. In the absence of a trial record—of course there never was one (but that's something I'm not free to explain to you now)—the judge has to go by what records are available. And in the case of an adjudged prisoner, McDivot's only legal choice was whether to sentence to life imprisonment, or execution.

The death of the kidnap victim, according to the statute, made the death penalty mandatory. Under the new laws governing length of time for appeal, which has been shortened because of the new system of computerizing records, to force an elimination of unfair delay and mental anguish to those condemned, I have five days in which to file an appeal, and ten to have it acted on.

Needless to say, I am not going to monkey with an appeal. I'm going directly to the Governor for a pardon—after which we will get this farce reversed. McDivot has already written the Governor, also, explaining that his sentence was ridiculous, but that he had no choice. Between the two of us, we ought to have a pardon in short order.

Then, I'll make the fur fly . . .
And we'll get in some fishing.

Best,
Mike

OFFICE OF THE
GOVERNOR OF ILLINOIS

June 17, 1966

Mr. Michael R. Reynolds
49 Water Street
Chicago, Illinois

Dear Mr. Reynolds:

In reply to your query about the request for pardon for Walter A. Child (A. Walter), may I inform you that the Governor is still on his trip with the Midwest Governors Committee, examining the Wall in Berlin. He should be back next Friday.

I will bring your request and letters to his attention the minute he returns.

Very truly yours,
Clara B. Jilks
Secretary to the Governor

June 27, 1966

Michael R. Reynolds
49 Water Street
Chicago, Illinois

Dear Mike:

Where is that pardon?

My execution date is only five days from now!

Walt

June 29, 1966

Walter A. Child (A. Walter)
Cell Block E
Illinois State Pententiary
Joilet, Illinois

Dear Walt:

The Governor returned, but was called away immediately to the White House in Washington to give his views on interstate sewage.

I am camping on his doorstep and will be on him the moment he arrives here.

Meanwhile, I agree with you about the seriousness of the situation. The warden at the prison there, Mr. Allen Magruder will bring this letter to you and have a private talk with you. I urge you to listen to what he has to say; and I enclose letters from your family also urging you to listen to Warden Magruder.

Yours,
Mike

June 30, 1966

Michael R. Reynolds
49 Water Street
Chicago, Illinois

Dear Mike:

(This letter being smuggled out by Warden Magruder)

As I was talking to Warden Magruder in my cell, here, news was brought to him that the Governor has at last returned for a while to Illinois, and will be in his office early tomorrow morning, Friday. So you will have time to get the pardon signed by him and delivered to the prison in time to stop my execution on Saturday.

Accordingly, I have turned down the Warden's kind offer of a chance to escape; since he told me he could by no means guarantee to have all the guards out of my way when I tried it; and there was a chance of my being killed escaping.

But now everything will straighten itself out. Actually, an experience as fantastic as this had to break down sometime under its own weight.

Best,
Walt

FOR THE SOVEREIGN
STATE OF ILLINOIS

I, Hubert Daniel Willikens, Governor of the State of Illinois, and invested with the authority and powers appertaining thereto, including the power to pardon those in my judgment wrongfully convicted or otherwise deserving of executive mercy, do this day of July 1, 1966 do announce and proclaim that Walter A. Child (A. Walter) now in custody as a consequence of erroneous conviction upon a crime of which he is entirely innocent, is fully and freely pardoned of said crime. And I do direct the necessary authorities having custody of the said Walter A. Child (A. Walter) in whatever place or places he may be held, to immediately free, release, and allow unhindered departure to him . . .

Interdepartmental Routing Service
PLEASE DO NOT FOLD,
MUTILATE, OR SPINDLE
THIS CARD

Failure to route Document properly.

To: Governor Hubert Daniel Willikens

Re: Pardon issued to Walter A. Child, July 1, 1966

Dear State Employee:

You have failed to attach your Routing Number.

PLEASE: Resubmit document with this card and form 876, explaining your authority for placing a TOP RUSH category on this document. Form 876 must be signed by your Departmental Superior.

RESUBMIT ON: Earliest possible date ROUTING SERVICE office is open. In this case, Tuesday, July 5, 1966

WARNING: Failure to submit form 876 WITH THE SIGNATURE OF YOUR SUPERIOR may make you liable to prosecution for misusing a Service of the State Government. A warrant may be issued for your arrest.

There are NO exceptions. YOU have been WARNED.

THE THINKING COMPUTER

by Bertram Raphael
Director, Artificial Intelligence Center
Stanford Research Institute

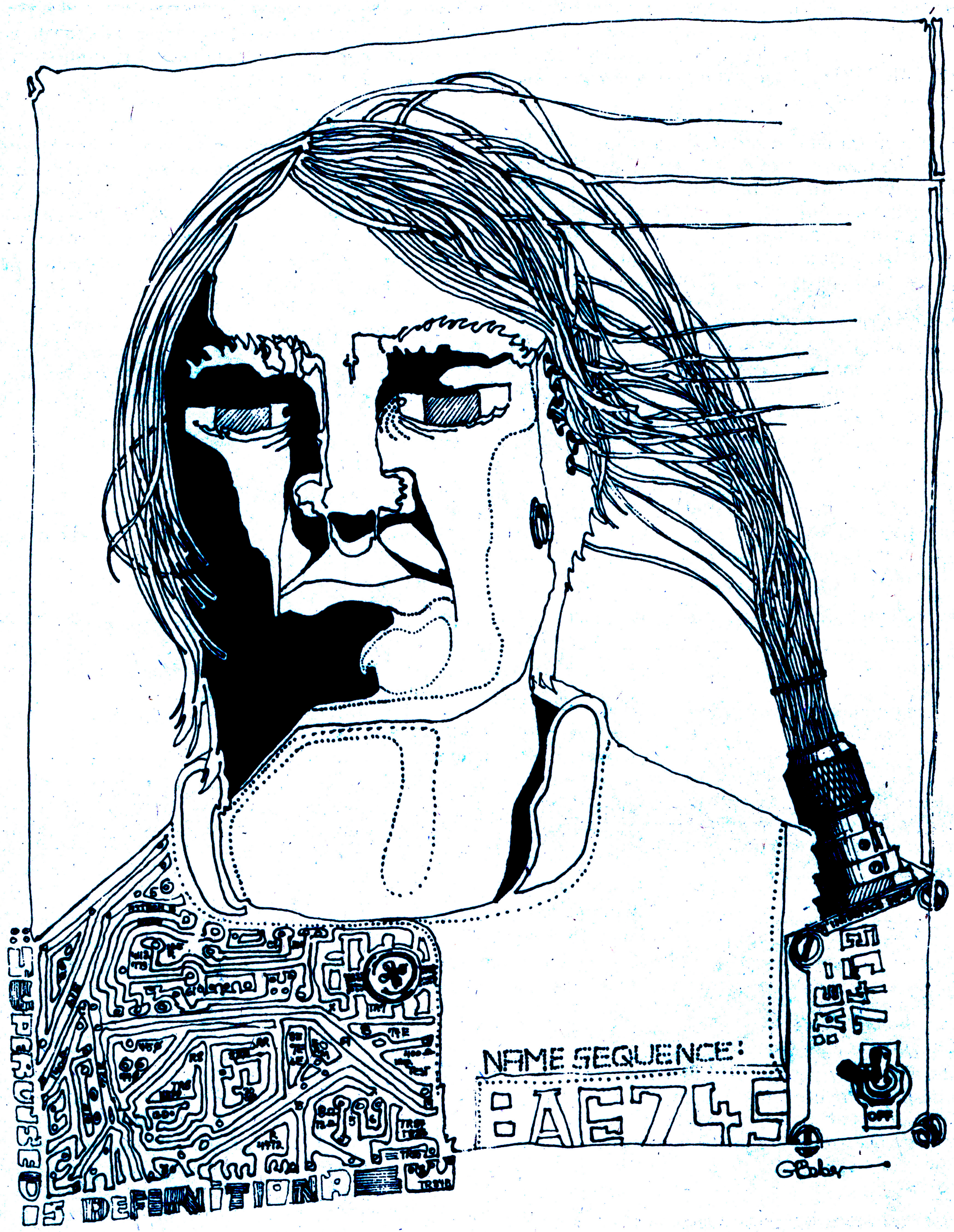

NAME SEQUENCE:
BAE745
DEFINITION
OFF
G Beker

Illustration by George Beker

Misleading Myths

Many people believe that computers are inherently stupid, and think that even a suggestion that computers might be made smarter is ridiculous. This belief is so widespread that most people never even consider the many ways in which smarter computers might help them. Misconceptions about a computer's limitations seem to be based upon two widely accepted but basically untrue premises. Let us examine these myths. By pointing out some of their fallacies, perhaps I can open your mind to the fascinating prospects for smarter computers.

THE ARITHMETIC MYTH. *A computer is nothing but a big fast arithmetic machine.*

Computers are arithmetic machines, certainly; almost every computer has wired into it the ability to add and subtract. But are they "nothing but" arithmetic machines? Certainly not. Take the reference manual for any computer, and scan through its "instruction set": the collection of basic operations it has been designed and wired to perform. You will see a few, perhaps as many as ten or twenty, operations that bear some close resemblance to arithmetic—e.g., ADD, DIVIDE, FLOATING SUBTRACT, MULTIPLY STEP, and so on—but you will also see many, perhaps one or two hundred, operations that have relatively little to do with arithmetic—e.g., STORE, LOAD, TEST, SHIFT, READ, WRITE, REWIND TAPE, SKIP, MOVE, MASK, MATCH, TRANSFER, and so on. Much of the time that any computer works on any problem, the computer is positioning, comparing, moving, choosing, copying . . . , but it is not doing arithmetic. Rather than calling a computer "nothing but a big fast arithmetic machine," it is much more accurate to say that a computer is *a big, fast, general-purpose symbol-manipulating machine.*

THE STUPID COMPUTER MYTH. *A computer is an obedient intellectual slave that can do only what it is told to do.*

This second myth is even more persistent than the first one, and even more damaging in the way it tends to constrain our thinking. Suppose I gave you the pieces of a jigsaw puzzle and told you, "by the way, these pieces cannot be fitted together." Would you try very hard to fit the pieces together? Why should anyone try to build a smart computer, if he is told over and over again that computers are inherently stupid?

The stupid-computer myth has been repeated and generally accepted for more than a hundred years. In 1842, after Professor Babbage of Cambridge designed his Analytical Engine, a large-scaled mechanical digital computer (which unfortunately was never completed), his friend Lady Lovelace wrote, "The Analytical Engine has no pretensions to *originate* anything. It can do *whatever we know how to order* it to perform." There is no question that Lady Lovelace's argument, and all the subsequent versions of the stupid-computer myth, are true, in a certain literal sense: a computer must be given its program of instructions, and it will always do exactly what those instructions tell it to do (unless, of course, one of its circuits fails). And yet this basic truth is not a real restriction on the intelligence of computers at all.

As novel sources of information, amusement, or artistic experiences, the potential for us to benefit from thinking computers is limited only by our imaginations.

This article consists largely of material from the book, *THE THINKING COMPUTER: Mind Inside Matter*, by Dr. Bertram Raphael which will be published early in 1976 by W.H. Freeman and Company.

The claim that a computer "can only do what it is told to do" does not mean that computers must be stupid; rather, it clarifies the challenge of how to make computers smarter; we must figure out how to tell (i.e., program) a computer to be smarter. Can we tell a computer how to learn? To create? To invent? Why not? I'd bet even Lady Lovelace would have agreed that the task of figuring out "how to order" a computer "to originate" something would be a fascinating and meaningful research challenge.

Progress in "artificial intelligence," the study of how to make computers smarter, is now enabling computers to apply a wide range of problem-solving methods; to communicate in ordinary English; to perceive the physical world; and to combine such abilities into flexible systems that perform useful tasks. The following paragraphs review some of this progress.

Problem-solving Methods

How do most people solve common, everyday problems? Suppose Mr. Pollack is driving to a ski resort in his little foreign car. On the way he encounters a snow storm, and finds he must mount his brand new tire chains on the wheels of his car. This problem—how to mount the chains on the wheels—can be divided into many little subproblems. Do the chains go on the front or the rear wheels? Should they be wrapped around a wheel by jacking the wheel off the ground, by driving the car onto the chains, or by figuring out how to use the funny little "mounting tools" that come with the chains? Which side of the chains should be up? How does the peculiar linking mechanism work? And so on. Mr. Pollack must solve these problems as quickly as possible, so that he can accomplish the task without freezing his fingers and soaking his clothes, and so that he can still get to the ski area without missing too much of the day's activities. Well, exactly how is this kind of problem usually attacked? By encoding the known facts into mathematical axioms, and using theorem-proving methods? Not likely! Instead Mr. Pollack (and millions of others) use *informal* problem-solving methods.

Informal problem-solving methods are especially intriguing because of their extreme generality. Problem-solving methods that most scientists develop work only in highly specialized, highly technical areas: e.g., a method for solving second-order linear differential equations with constant coefficients, or a method for estimating the distances of stars less than twenty light years away. Informal problem-solving methods, in contrast, seem to be applicable to a wide variety of problems, most of which may be brand new to the person using the methods: even though Mr. Pollack may never have been called upon to mount tire chains before, he need not be at a total loss as to how to proceed. Is there some standard way of viewing any task, that enables people to apply their reasoning abilities with flexibility to any problem that arises? Psychologists have developed various approaches to explaining such complex cognitive behavior. One approach that has been embodied in a computer program, called the General Problem Solver (GPS), demonstrates a way to redirect a single central mechanism to a variety of different tasks with a minimum of effort.

An important feature of GPS is that it separates task-dependent information—the detailed description of a particular problem, the actions or "operators" available for use in solving the problem, and the desired results or "goal"—from task-independent reasoning methods that may be useful for many different types of problems. Various strategies for finding an effective sequence of operators can be proposed, and the GPS computer program, developed at Carnegie-Mellon University, is a tool for comparing and experimenting with such proposals.

GPS has a major advantage over more formal search algorithms. It does not have to select operators in sequence from the first operator, which is to be applied to the initial problem, to the last operator, which is to reach the goal. Instead, it looks at the initial problem and the goal, and goes to work on trying to reduce the most important difference between them. The operator that succeeds in reducing this difference might eventually have to be applied somewhere in the middle of the complete sequence of operators that solves the problem. By deciding upon this operator first, the problem solver overcomes a major hurdle and replaces the entire task by two simpler subtasks: getting from the initial situation to one in which the chosen key operator can properly be used, and getting from the state that exists after that operator is used to a final solution.

Consider Mr. Pollack's chain-mounting problem again. A straight-forward search procedure for figuring out how to put on the chains would consider first the alternative actions that are immediately possible when he stops his car: wait for the snow to melt, or try to drive on without chains, or turn around and go back home, or get out of the car. If we assume he gets out of the car and is standing in the snow storm, his next choices might include: get back into the car, or open the trunk, or jump up and down to keep warm. If he opens the trunk, then he can get the chains out, or get the jack out, or get the suitcases out, or crawl in, and so on. Eventually, if he follows the most direct course of action, he will find himself lying in the slush under the car, with the chain wrapped around the wheel, and his fingers jammed up between the freezing axle housing and the hot exhaust pipe, trying to figure out how the new-fangled linking mechanism works.

The GPS approach might begin by observing that a key difference between having no chains on the wheels and having chains that work correctly on the wheels is that each chain must be linked onto a wheel. Therefore an understanding of the linking mechanism may be singled out as the first problem that must be solved. This problem can be tackled by studying the manufacturer's directions or by experimenting with the actual chains, while seated in the warm dry car. Once the linking mechanism is understood, the next problem is how to get to a situation in which it is appropriate to close the links, so he might then focus attention on the wrap-the-chain-around-the-wheel problem. Thus the overall task is broken down into a sequence of progressively less crucial subproblems whose solutions each fill in a different portion of the overall solution.

Around 1969 scientists at Stanford Research Institute developed a problem-solving system to control an experimental robot. This system, called STRIPS, combines some of the best features of deductive theorem-proving methods, with informal GPS-like problem solving. One of the difficulties with using GPS was that the user had very little guidance as to how to represent his problem in the computer. GPS dealt purely with abstract notions such as objects, operators, and differences, and its success depended to a great extent upon special characteristics of those objects, operators, and differences, that the user invented for himself. The principal contribution of STRIPS is to embed into a GPS-like framework a set of specifications for the nature of objects and operators, and a resulting automatic method for obtaining differences. Of course, the user must still construct a specific representation for each specific problem, but STRIPS at least tells him the form that that representation must take.

Current directions in problem-solving research include the development of new programming languages that incorporate earlier problem-solving techniques; studies of ways to use man-machine systems more effectively in cooperative problem-solving activities; methods to allow problem-solving systems to use computer simulation techniques when appropriate; and the growth of large data bases so that problem-solving systems can have access to the general knowledge they require.

Natural Language

Linguists are actively working on theories to explain the nature of language and its semantics. However, technology does not usually wait for theories to be completed. While the linguists carry on their theoretical studies, computer scientists have also been studying how computers can be made to understand natural language. These studies have been conducted from an experimental engineering point of view.

Many of the experimental language-processing programs fall in a general category called *question-answering systems*. A question-answering system may be defined as any computer program that understands the information typed into it, and demonstrates that it understands by answering questions about the information. The ideal question-answering system should be able to: (1) accept facts and questions, and make appropriate responses, all in the form of natural English; (2) store, remember, and make efficient use of a large amount of data—at least thousands of elementary facts; (3) answer questions that require it to figure out the logical consequences of the facts stored explicitly in its memory; and (4) operate conversationally—e.g., via a time-sharing computer terminal—without frustrating delays. Although no system yet developed has all four of these capabilities a significant degree of success in each of the four areas has been separately achieved by various systems. In the next few years we should begin to see these capabilities combined and improved, producing the first true, complete question-answering systems.

We would like computers to be able to understand not only typed and printed, but also *spoken* natural language. For many years research in the field of "speech recognition" focused upon identifying individual words purely on the basis of their sounds, and progress was limited. Now scientists recognize that understanding spoken language involves using many sources of knowledge—such as knowledge of vocabulary, syntax, and subject matter—in addition to the perceived sounds themselves. Speech-understanding systems now under development integrate such multiple sources of knowledge about language in order to come up with an accurate understanding of what has been said.

Perception

Suppose you are about to open some presents. Do you need to unwrap each item completely and look at it in a strong light in order to recognize what it is? Not usually. One handlebar sticking out of a large, formless wrapping is enough to identify the bicycle you had been expecting. If it's Christmas morning and a small flat box has a tag showing that it came from Aunt Agnes, you might know it contains another hideous tie. On the other hand, if the occasion is your bar-mitzvah, then you can be pretty sure that every small flat box contains another pen-and-pencil set. If you don't come to any such quick conclusion, you might examine the mysterious package more closely, look at the tag or postmark, lift it to feel its weight, shake it to see if it rattles or sloshes, and you usually will have a pretty good chance of perceiving what's inside without ever seeing it. Similarly, it is unfair to expect a computer to recognize real objects unless it first knows something about the expected characteristics of the objects, such as their size, shape, color, and the normal physical relationships among them.

Many of the past computer-vision projects tried to "simplify" their tasks by aiming their TV cameras only at artificial objects like boxes and wedges, which had straight-line edges and clear mathematical descriptions. Unfortunately, such objects have few expected sizes or shapes, no normal physical relationships, and rarely any context to guide the recognition process. Because of this, paradoxically, the attempt to simplify may actually have made the recognition problem more difficult.

Current research is turning to more natural pictures that may incorporate curved objects and complex surroundings. "Scene understanding systems" are now being built that coordinate the use of several kinds and sources of knowledge in order to solve complex problems. For example, knowledge of illumination, distance measurements, color, spatial relationships, and physical constraints, can all contribute to the accuracy of the interpretation of visual data.

Robots

I am not going to define the word "robot" here, because of the wide range of interpretations it has. The following examples indicate the general kinds of devices that we shall consider. Without getting enmeshed in the technical details of how they work, let's look at what some of these systems were capable of doing a few years ago.

At Hitachi Central Research Laboratory a TV camera was aimed at an engineering plan drawing of a structure built out of various-shaped blocks. A second camera looked at the blocks themselves, which were spread out on a table. The computer "understood" the drawing, reached towards the blocks with its arm, and built the structure.

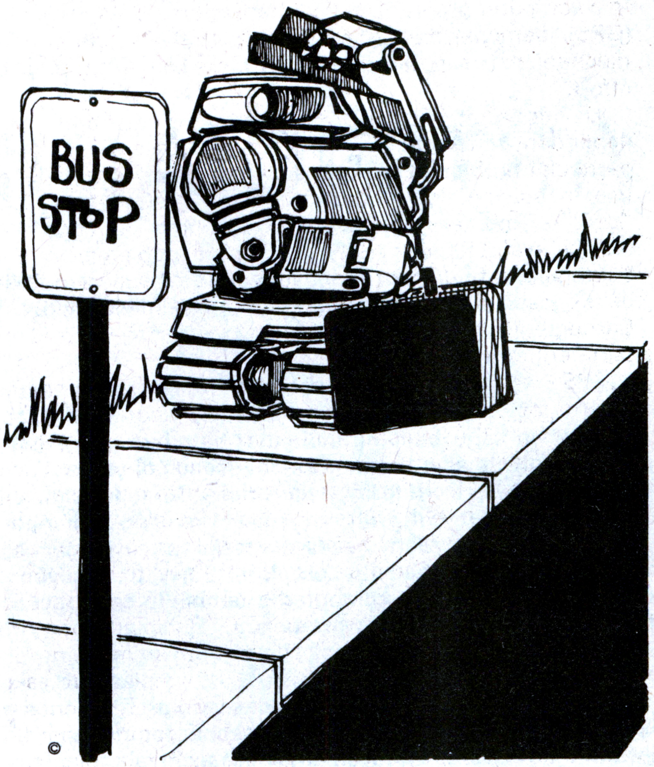
At MIT, the camera was not shown a plan; instead, it was shown an example of the actual structure desired. The computer figured out how the structure could be constructed, and then built an exact copy.

At Stanford University, the hand obeyed spoken directions. For example, if someone said into the microphone, "Pick up the small block on the left," that is precisely what the arm would do.

At the University of Edinburgh, a jumble of parts for two wooden toys was placed on the movable table near the camera. "Freddy," the Edinburgh hand-eye-table robot system, carefully spread out the parts so that it could see each one clearly, and then, with the help of a vise-like work station at one corner of the table, assembled first the toy car and then the toy boat.

At SRI, Shakey the mobile robot was told to "PUSH THE BOX OFF THE PLATFORM." Shakey had no arm, and realized that he could not reach the box unless he was on the platform with it. He looked around, found a ramp, pushed the ramp up against the platform, rolled up the ramp, and then pushed the box onto the floor.

Recently, robot researchers have been concentrating their efforts upon specific technical problems that must be solved in order to create more powerful robot systems. Major developments coming out of current work include: (1) new hardware technology that is leading to more reliable and less expensive sensors, effectors, and computers; (2) new software technology, in the form of high-level programming tools and studies of how to structure the large knowledge bases that are essential for any intelligent system; and (3) prototypes of simple robot systems that can at least begin to perform truly practical tasks. For example:



At Stanford the hand-eye system that used to stack toy blocks can now assemble a real water pump.

At SRI a computer-controlled Unimate industrial manipulator arm with touch and force sensors can feel its way as it packs assembled pumps into a case.

At MIT programs are under development to enable a computer to inspect and repair circuit boards for use in computers, TV sets, and other electronic equipment.

Applications

As computers become less expensive and more widely available, society is becoming more dependent upon them to perform conventional bookkeeping functions. More important, however, is that as computers become more intelligent they can take on valuable new roles in the service of society. In education, computers constitute a rich new medium for a student's creative expression and experimentation. They can be used to demonstrate laws of physics on a dynamic display screen, to illustrate mathematical principles through the design of algorithms, and to carry on tutorial conversations. In psychology, computer models of mental behavior provide knowledge of how the mind works. In medicine, computers can model physiological and biochemical processes, and both store and deduce large numbers of facts about diseases, drugs, and treatments. In industry, computers can help both in the front office, scheduling activities and monitoring progress, and on the factory floor, directing automatic inspection, materials handling, and assembly systems. Such activities can both increase productivity and improve the quality of the goods produced. In mathematics and science, computers are beginning to function as intelligent assistants to professional scientists, performing such jobs as solving and simplifying symbolic equations, analyzing chemical compounds, and verifying the correctness of simple computer programs. As novel sources of information, amusement, or artistic experiences, the potential for us to benefit from thinking computers is limited only by our imaginations.

Primer on ARTIFICIAL INTELLIGENCE

by Lewis E. Garrett
Del Mar College, Corpus Christi, Texas

I. INTRODUCTION

Man has been building tools that help him in solving problems of his environment for thousands of years. The earliest tools were crude knives and axes. But today simple single purpose tools will not solve mankind's myriad complex problems. Many necessary tasks can no longer be accomplished by human intellect alone. So, with the advent of the electronic digital computer, attempts to construct a new problem-solving tool were begun.

Purpose of the Primer

The purpose of this primer is to describe artificial intelligence and to show the various approaches for attaining it. Information is presented on the necessary elements of artificial intelligence, the types of research that have been conducted, and the 'state-of-the-art' of artificial intelligence research. It is the writer's intent to inform interested persons on the many facets of artificially intelligent processes.

Scope

Readers of this primer are not required to be computer experts. The only requirement is an interest in 'thinking' computers. No attempt is made to describe in-depth computer programming techniques. The reader should realize that a digital computer basically has only two outstanding abilities: the ability to perform arithmetic computations and the ability to compare two quantities and determine which is the largest. Both of these operations are performed exceptionally quickly. The discussion of artificial intelligence will center on its parts as a function of the whole and will not give the reader the understanding necessary for writing a computer program that exhibits artificially intelligent behavior.

History

The term 'artificial intelligence' has, since its inception, come to mean the mechanization of thought processes. It can be classified into at least four distinct areas: game playing, language translation, problem solving, and pattern recognition. Work in these areas could not really begin until the advent of the general purpose digital computer in the early 1950's.

Each area of artificial intelligence has had dramatic early success followed by unexpected difficulties. These early successes prompted men like Herbert Simon to make enormous predictions about the future of artificial intelligence. Mr. Simon said in 1957: "... within ten years a digital computer will be the world's chess champion ...." This promise has not been realized.

Early successes were realized by Newell, Shaw, and Simon at Carnegie Institute of Technology. They concentrated on the simulation of human thought processes (artificial intelligence) with emphasis in the area of games and problem solving. One program known as the Logic Theorist, in 1957, was able to provide proofs of 38 out of 52 theorems from *Principia Mathematica*.

Another area of early success was in the mechanical translation of languages. In 1954 Anthony Oettinger devised the first mechanical dictionary for the translation of English into Russian. During the ten years following the development of this mechanical dictionary, about $20 million was spent on mechanical translation research by various governmental agencies.

Definitions

Artificial intelligence is best defined in the words of Marvin Minsky as: "... the science of making machines do things that would require intelligence if done by men." This definition reflects the core of this primer.

II. INTELLIGENCE

"Intelligence surely can exist only within very intricate structures." This statement by Marvin Minsky sums up rather neatly the problem of artificial intelligence. So it is that a study of artificial intelligence cannot be undertaken without a companion look at what constitutes 'natural intelligence'. This will lead to a better understanding of what must compose 'synthetic intelligence,' and how the two compare to each other.

Natural Intelligence

Some people think that humans have two qualitatively different resources for information processing. The first is a unit for controlling the functions of all the other units (a central processing unit). The operations of this central processing unit are carried out one at a time, that is, serially. The second resource is a network of interconnected elements which act in parallel. This means that the elements are available simultaneously for contribution to the information process. Another theory has man's central processing unit also performing operations in parallel. Although agreement is not unanimous on whether or not man's brain performs operations in parallel or in series, the nature of the second resource of the brain (network) is, for the most part, agreed upon.

Mechanics of the Human Brain. The human brain is composed of approximately 10^{10} neurons (nerve fibers). These nerve fibers come together to form junction points or what is known as synapses (Fig. 1). Neural physiologists are far from completely understanding how neurons operate and are interconnected but, many believe, the basic functions are performed by an 'on or off' process.

This 'on or off' function is an electrical process performed at the synapses. The nerve fibers conduct electrical impulses to the synapses. This results in the synapses being either 'excited' or 'inhibited.' Excitation occurs when the sum of several input pulses exceeds the 'threshold' voltage for that synapse. A synapse is inhibited when the electrical impulses are not sufficient to exceed the 'threshold' (Fig. 2). This stimulation or inhibition effect can also be thought of as the 'on or off' effect of the neurons on the synapses.

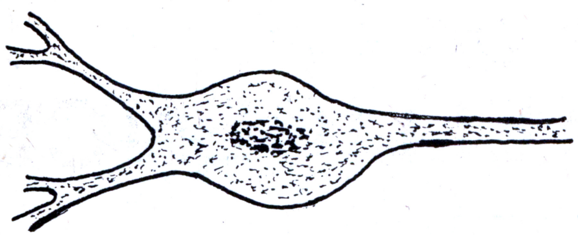


Fig. 1
SYNAPSE

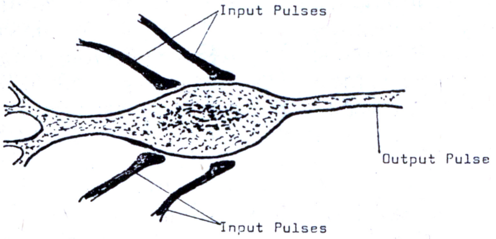


Fig. 2
SYNAPSE WITH EXCITATION

The trillions of connections between nerve fibers explain the human brain's ability to think. This is especially true since the human mind can use tens of thousands of nerve fiber chains simultaneously in performing an intelligent act. Although the individual actions which occur in this 'neural net' can be visualized and understood, the multiplicity of effect cannot be. If this process were understood, the question of how to create artificial intelligence would also be understood.

Human Behavior. Newell, Shaw, and Simon are convinced that free human behavior is based on a complex but determinate set of laws. Since the human memory capacity is estimated to be at least a million billion bits of information the truth of their conviction cannot be readily proved.

Many people think that human intelligence has evolved through a lengthy process of mutation and natural selection. Others think that this intelligence is based on natural neural networks alone. Whichever theory is used, natural intelligence appears to be essentially a trial and error process.

The words of Donald N. Streeter serve quite well to sum human behavior: "Man is inventive and flexible. He perceives, abstracts, and associates quite well, drawing on broad experience to make decisions and check reasonableness. However, he is forgetful of detail, inaccurate, and subject to boredom and fatigue."

Synthetic Intelligence

Any process which can be formalized so that it can be represented as a series of instructions can, in principle, be reproduced by a computer. This idea is the basis for the artificial intelligence researcher's belief in an eventual solution. Marvin Minsky states: "... that at least some mentalist description of thought processes can be turned into specifications for the design of machines or, what is the same thing, the design of programs."

Mechanics of the Digital Computer. The electronic digital computer is basically a block diagram consisting of three functions: input, process, and output. These functions are performed by various pieces of hardware: the central processing unit, the arithmetic logical unit, storage (memory), and the input-output devices (Fig. 3).

The central processing unit controls all the other elements of the computer. The storage of the computer holds instructions awaiting execution. The arithmetic logical unit performs comparisons and does arithmetic. And the input-output devices receive and issue information. All of these units, working in tandem, form the physical make-up of the electronic digital computer.

The actual processing within a computer is binary in nature, that is, it is controlled by the 'on or off' condition of discrete bits of information. This is accomplished by using electronic memory devices (core, semiconductor, bubble, charge couple memory, etc.) having either an 'on' or 'off' state.

Work done by a computer is controlled by its 'software. Software is a set of instructions for events to take place within a machine. These instructions are placed in storage where they are performed serially, that is, one at a time. Computers perform these operations in nanoseconds (10^{-9} sec.).

Synthetic Behavior. "Research scientists in Artificial Intelligence try to get machines to exhibit behavior that we call intelligent behavior when we observe it in human beings." In Dr. James R. Slagle's words, we can see that the search for artificial intelligence is really an attempt to duplicate human behavior. Thus it is that there are three schools of thought concerned with finding the answer. The three approaches are: artificial evolution, artificial networks, and heuristic programming.

Artificial evolution is an approach whereby computer simulated systems are made to evolve by mutation and selection. The main disadvantage of this approach is that it is practical only if artificial evolution can be made to proceed enormously faster than natural evolution.

Artificial networks are a large number of simple elements and their interconnections. Its main advantage is that, using this approach, the system is adaptive to new situations and can learn from experience. The disadvantage is that there is little prospect of making an artificial network as large as the network in the human brain.

The heuristic programming approach uses heuristics in attempts to solve problems. A heuristic is a 'rule-of-thumb' used to solve a particular problem. This technique, combined with the computer's computational power, has had a margin of success. But success is limited by the programmer's ability to conceive 'rules-of-thumb' for application to the problem.

Again, Donald N. Streeter's words are most apt for summing up: "Computer systems, compared to humans, are fast, accurate, and consistent in recalling and processing information, but are inflexible, requiring detailed pre-programming for all situations to be dealt with."

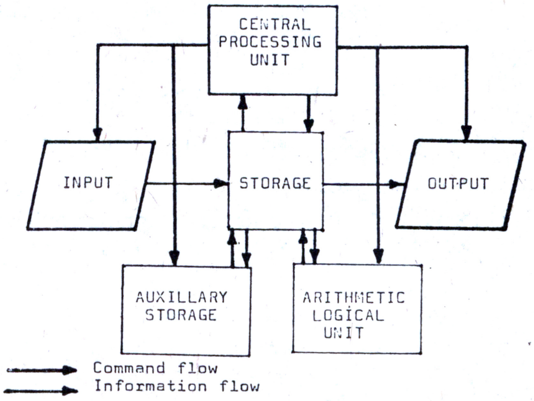


Fig. 3
COMPUTER DEVICE RELATIONS

Comparisons

The human nervous system is intricately more complex than that of the computer but is more sluggish in handling messages (Fig. 4). The reasons for this are found in the speeds with which electrical impulses are transmitted. Human nerve pulses last about one thousandth of a second whereas typical computer pulses last only a few billionths of a second. Hence, the human brain can process only 50 billion bits of information within a conscious lifetime, while the computer can process this same number within a couple of hours.

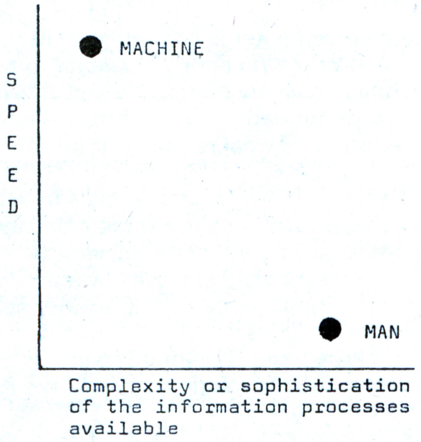


Fig. 4
COMPARISON OF MAN AND MACHINE

III. ELEMENTS NECESSARY FOR ARTIFICIAL INTELLIGENCE

A machine must have facilities for representing and analyzing its own goals and resources. There are three basic elements necessary to achieve true artificial intelligence: memory, pattern recognition, and learning.

Memory

It is assumed that the long-term storage of information and data in the brain is necessary to learning. Memory is, in actuality, a problem of recognition. This is true because facts are rarely at hand in the form they are needed. Man's pattern recognition of data is largely due to his fabulous memory system and its ability to classify information. If 225,000,000,000 computers (IBM 370/135 or equivalent) were connected together, they still would not achieve the memory capacity of the human brain.

Pattern Recognition

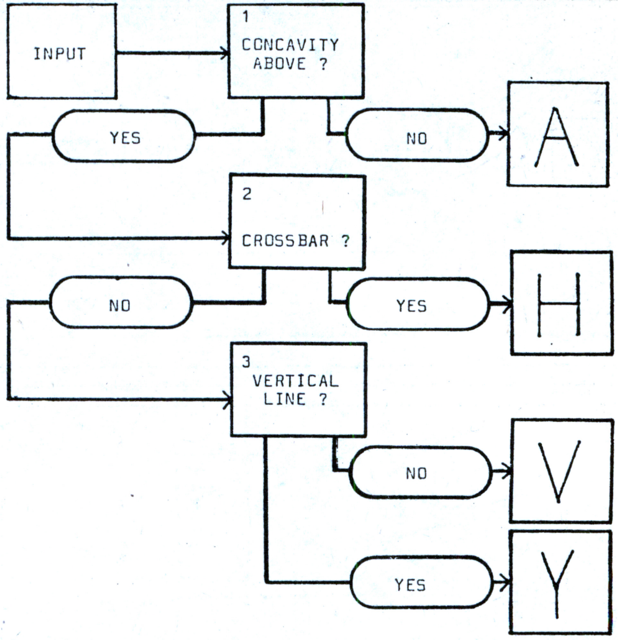
Many of the problems in artificial intelligence are in pattern recognition such as identifying printed letters (Fig. 5).

Pattern recognition techniques are necessary in order to cut down on the possibilities to be considered in solving a problem. Unless this is done, the search for a solution becomes exponential in growth, and soon outstrips the limits of the computer.

At present, pattern recognition programs do not even approach the flexibility of human pattern recognition abilities. Until they do, true artificial intelligence will not be possible.

Learning

Over 2300 years ago the Greek philosopher Aristotle studied the process of associative learning. For centuries man has been fascinated by this learning process. The two most important families of contemporary learning theory are: Stimulus-Response theorist and Cognitive field (or Gestalt) theorist.



Sequential-processing program for distinguishing four letters, A, H, V and Y, employs three test features: presence or absence of a concavity above, a crossbar, and a vertical line. The tests are applied in order, with each outcome determining the next step.

Fig. 5
PATTERN RECOGNITION

Stimulus-Response. Under Stimulus-Response, behavior is seen as a transaction between the stimuli that impinge an organism, and the resulting response. The Stimulus-Response theorist sees learning as a permanent relation between stimulus and response.

In the early 1900's American psychologist E.L. Thorndike formulated the Law of Effect—when a person repeatedly does something successfully, the neural pathways become reinforced; when a person repeatedly fails to do something successfully, the neural pathways become inhibited. Ivan Pavlov's famous experiments with the salivation of a dog when a bell rings illustrates this theory quite well.

Current computer programs, for the most part, follow the Stimulus-Response theory since the same input usually engenders the same output.

Gestalt. Gestalt is a German word which means a configuration has characteristics more broadly based than those of its parts. Gestalt psychology originated in Germany in the early part of the 20th century with four psychologists: Max Wertheimer, Wolfgang Kohler, Kurt Koffka, and Kurt Lewin. Gestalt theorists see learning as goal-oriented with the learner being creatively bent.

Researchers in artificial intelligence using Gestalt theories as their guide generally analyze techniques human subjects employ and then incorporate them into a program. Generally this type of research is called Cognitive Simulation.

Cognitive Simulation (Gestalt) in artificial intelligence research was marked by early success. Unfortunately, the successes diminished quite rapidly until researchers became disenchanted with this approach.

Feedback in the Learning Process. Learning is necessarily a goal-seeking process and feedback is inherent in it. In practice, feedback is the process of regulating a procedure or system by returning information gained from its outputs to its inputs (Fig. 9). In order for a system to obtain feedback information, it must be able to develop associative patterns from which it can determine how to use the feedback information (Fig. 10). In other words, a system must be told something for it to learn something.

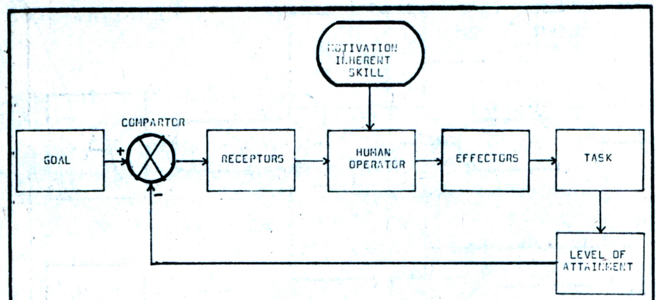


Fig. 6
FEEDBACK NATURE OF

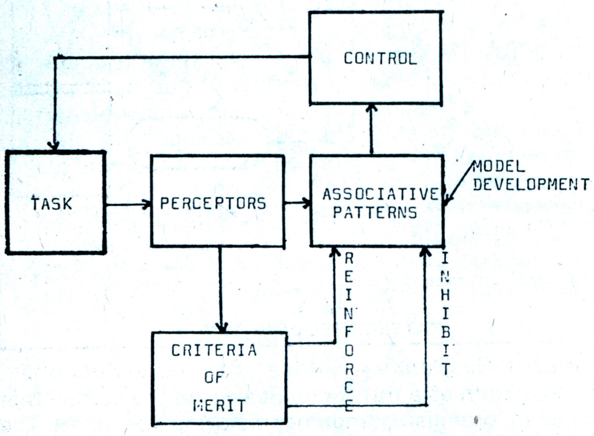


Fig.7
DEVELOPMENT OF ASSOCIATIVE
PATTERNS (MODELS)
IN LEARNING A TASK

IV. TYPES OF RESEARCH IN ARTIFICIAL INTELLIGENCE

There are many subjects that the artificial intelligence researcher has used as a vehicle toward understanding this complex subject. In addition to other areas, language translation and games are two of the broadest.

Language Translation

It was hoped in the early days of research in language translation that programs could be written that would act as automatic translators and interpreters of natural languages. These programs would perform the same type of functions as interpreters at the United Nations. It was also hoped that programs could be written for retrieving natural language text from a computer.

It seemed likely that encoding a relatively few basic words in a language translation program could be used as a 'bootstrap' toward the program's associating of new words (Fig. 8). But, after much work using this idea, researchers conclude that this is too difficult for our present stages of knowledge. Machine translation of typed scientific texts, let alone spoken language, is beyond our reach for the present.

Some researchers suggest that we do not understand our own language process well enough to replicate it with the computer.

Games

Programming computers to play games has several purposes. First, games resemble many real problems. Second, in games, the problem is well defined, thus easier to work with. The third reason is that doing so may lend solutions for the solving of real problems. And finally, it's fun. Young animals have played games for eons in order to prepare for the real business of living. Game-playing on computers has a similar purpose for the computer scientist.

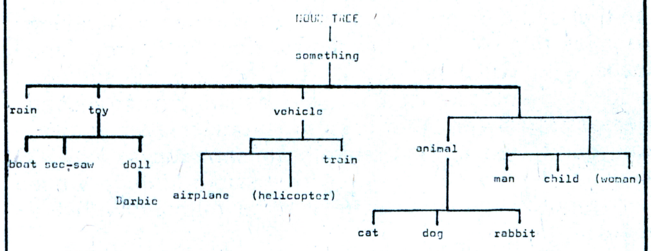


Fig. 8
A WORD ASSOCIATION MODEL

An important part of many game-playing programs is a procedure for searching a 'tree' of logical possibilities. Indeed, this is essential for any problem solving to take place. The problem of trees is that the total number of alternatives available to us are far too many to be exhaustively searched. In order to guarantee a perfect first move in the game of checkers, for example, the program would have to decide its move on the basis of about 10^{40} possibilities. In the game of chess, this figure would be about 10^{120} possibilities. Therefore, it is easy to see that a method must be used to 'prune' this gametree, and thus cut down on the number of alternatives to be considered.

One of the greatest achievements in the field of artificial intelligence has been a computer program to play draughts written by Dr. Arthur Samuel in 1967. This program takes about one minute to make its move and consistently beats Dr. Samuels, who is a good checker player himself. Although the World's Champion Checker Player has beaten the program four out of four games, the program beat the champion of Connecticut once.

Even though the game of checkers has yielded somewhat to researchers, the game of chess has not. Computer programs to play chess are still not proficient at the game, despite predictions that a computer would be the world's champion chess player by 1967.

Other Research

John G. Chubbock, A. George Carlton, and others at the Applied Physics Laboratory of Johns Hopkins University have developed a device they call The Beast. The Beast is a battery-operated cylinder on wheels which roams the halls and plugs itself into an electrical outlet whenever its batteries become depleted. It has been known to 'survive' for as long as 40 hours without running down its batteries. Research in this area could be extremely useful in learning how to construct robots to be used in hostile environments, or to automatically chauffeur automobiles. Another use could be in an unmanned space ship going to Mars. Immediate computer response to unexpected problems would be essential since communications between Earth and Mars would take a couple of minutes.

Another area of artificial intelligence research has been with computer programs called General Problem Solvers. Variants of this type of program attempt to simulate human behavior. Tests between a General Problem Solver and a college student have shown amazing similarities between thought processes of the student and the General Problem Solver. Although this area has been abandoned as a viable approach to artificial intelligence, it has served to broaden the researcher's outlook as to the problems of mechanizing thought processes.

V. STATE-OF-THE-ART

Research in the field of artificial intelligence has yielded much fruit since its infancy only twenty-five years ago. But the fruit it has borne is nothing compared to what it must bear in the future if it is to realize the predictions of its adherents.

Accomplishments

Artificial intelligence is a regenerative science; that is, accomplishments of today rapidly build those of tomorrow. This can probably be said about any field of endeavor, but nowhere is it more true than here. The reason being that, as we progress, the computer becomes stronger and more capable of aiding the researcher in his quest.

Research in artificial intelligence has given various by-products such as assembly programs, debugging programs, test editing programs, and even a good mechanical arm developed at the Massachusetts Institute of Technology. There have been programs written that compose music and some that find chemical structures. In addition, there have been extremely complex programs written which handle such diverse tasks as traffic control, aiding architectural design, aiding electronic circuit design, monitoring patients in a hospital, and simulating chemical reactions.

By definition, artificial intelligence must have the ability to adapt to its environment and react to totally unforeseen circumstances. Although much has been accomplished, almost all computer applications fail to qualify as artificial intelligence under this definition.

Goals

The basic problem in artificial intelligence, as yet unresolved, is that all alternatives must be made explicit. Ways must be found for programs to determine useful information out of collections of seemingly random bits of information.

Computer programs must have shortcuts, similar in nature to those used by the human brain, built into them. In addition, they must be able to deal with facts about objects, relations between objects, and facts about facts. Also, all behaviors must be representable by the program, and it must be able to have or evolve concepts of partial success.

Furthermore, creative purpose is absent in the computer. In the words of Donald G. Fink: "At best, today's computers can only assist man in creative work." If artificial intelligence is to become an actuality, then one of the highest goals of the researcher must be to find ways to give machines creative purpose.

Computers are not constrained by a sociological environment; their only limitations are imposed by the programs given to them. Therefore, we must be sure that the 'top goal' given to a highly intelligent machine be the welfare of humanity, and not some private goal of the machine. As David Kendall said in the preface of a 1967 book of collected papers on machine intelligence: "Thus a study of 'Machine Intelligence' leads after yet one more remove to the ancient imperative, 'know thyself' and the universal problem of coexistence."

Predictions

There have been many predictions made in regard to the progress of artificial intelligence research. Among these is the 1965 prediction by Simon that: "... machines will be capable, within twenty years, of doing any work that a man can do." On the other side of the coin is the statement by P. E. Greenwood: "From the brief summary of the state of the art of artificial intelligence, one would conclude that little progress has been made since about 1960 and the prospects for the near future are not bright." Whichever side one decides to take, there are ample adherents to each.

Marvin Minsky sums it up nicely:

> *Once we have devised programs with a genuine capacity for self-improvement a rapid evolutionary process will begin. As the machine improves both itself and its model of itself, we shall begin to see all the phenomena associated with the terms 'consciousness,' 'intuition,' and 'intelligence' itself. It is hard to say how close we are to this threshold, but once it is crossed the world will not be the same.*

VI. CONCLUSION

Artificial intelligence is a young science. Only time and the persistence of artificial intelligence researchers will reveal the full measure of its potential.

The late A.M. Turing laid down a test for adaptive intelligence. The test, which has come to be known widely as the Turing Test, is very simple. It consists of a man (the examiner) trying to discern whether or not the responses to questions he has proposed are being answered by a computer or another man. The test is conducted in such a way that the questioner can not physically determine which respondent has produced the response to his question; he must make the determination solely from the answer itself. So far, no one has been able to write a program that can consistently fool the examiner in the Turing Test. Until this is done, true artificial intelligence will remain within the realm of science fiction.

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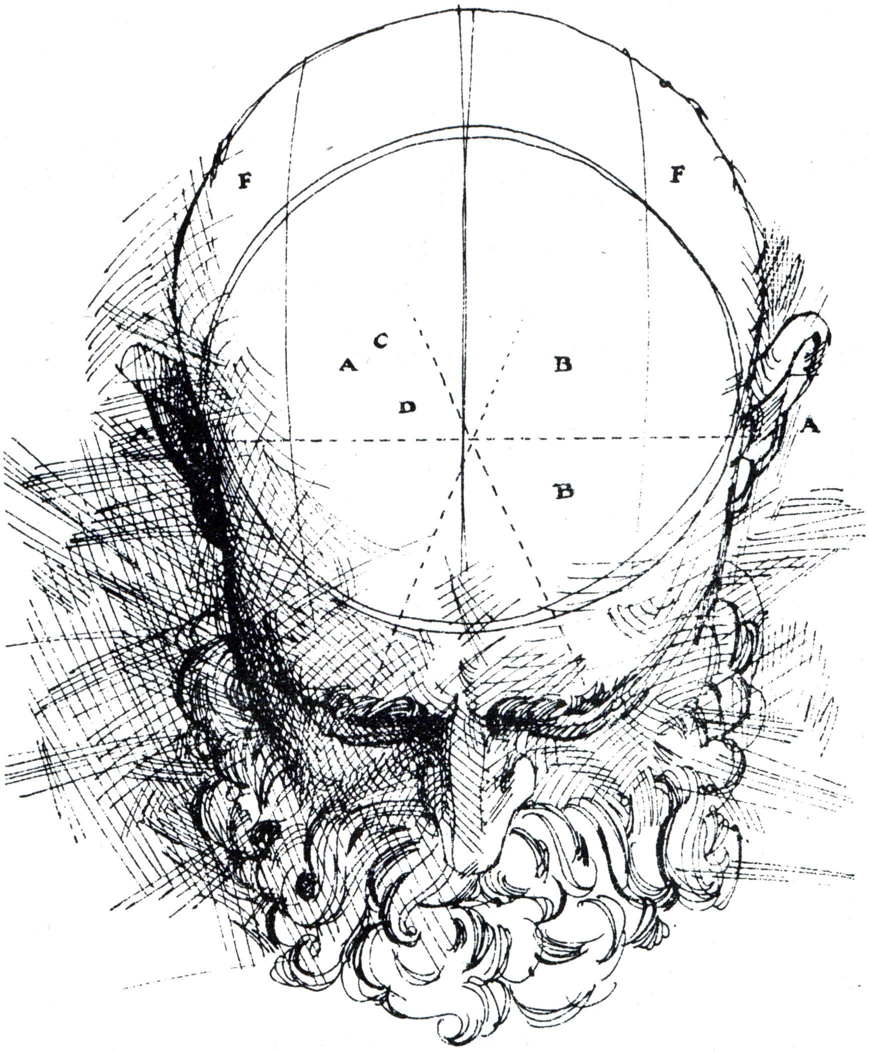


Can Computers Think?

by David H. Ahl

"A Bird is an instrument working according to mathematical law, which instrument it is within the capacity of man to reproduce with all its movements."

Leonardo da Vinci (1452-1519)

Intelligent Machines and Today's Digital Computer
A common attitude toward today's computers is that such machines are strictly arithmetic devices. While it is true that machines were first built to carry out repetitive arithmetic operations, they are capable of other, nonnumeric tasks. The essence of the computer is the manipulation of symbols—it is only a historical accident that the first application involved numeric symbols. This incorrect notion of the computer as a strictly numeric device results in the inability of many to conceive of the computer as a device exhibiting intelligent behavior, since this would require that the process be reduced to a numerical one. The reaction of many people to statements about intelligent behavior by machines seems to indicate that they take such statements to imply complete functional equivalence between the machine and the human brain. Since this complete functional equivalence does not exist, such people believe they have thereby debunked intelligent machines. Their conclusion is incorrect because this equivalence was never implied. Intelligent behavior on the part of a machine no more implies complete functional equivalence between machine and brain than flying by an airplane implies complete functional equivalence between plane and bird.

The concept of comparing the behavior of men and machines in an n-dimensional continuum recognizes differences as well as similarities. For example, a common argument against machine intelligence is that the brain is a living thing—the machine is not. In our continuum we simply recognize the dimension of living and note that machines and men occupy different positions on this dimension.

Is It Possible for Computers to Think?
No—if one defines thinking as an activity peculiarly and exclusively human. Any such behavior in machines, therefore, would have to be called thinking-like behavior.

No—if one postulates that there is something in the essence of thinking which is inscrutable, mysterious, mystical.

Yes—if one admits that the question is to be answered by experiment and observation, comparing the behavior of the computer with that behavior of human beings to which the term "thinking" is generally applied.

The two negative views are unscientifically dogmatic. The positive, or empirical, view is supported by scientists who point out that there exists a continuum of intelligent behavior and that the question of how far we can push machines out along that continuum is to be answered by research, not dogma. One might add a further qualification: to assert that thinking machines are possible is not necessarily to assert that thinking machines with human capabilities already exist (or even that they will exist in the near future).

What, then, is the goal of artificial intelligence research? It seems to be this: to construct computer programs which exhibit behavior that we call "intelligent behavior" when we observe it in human beings. Because this research area is still in the formative stage, many different research paths are being explored and a wide diversity of results have been produced.

But Doesn't a Computer Do Exactly What It Is Told To Do and No More?

Commenting on this familiar question, a well-known researcher in the field had this to say:

This statement—that computers can do only what they are programmed to do—is intuitively obvious, indubitably true, and supports none of the implications that are commonly drawn from it.

A human being can think, learn, and create because the program his biological endowment gives him, together with the changes in that program produced by interaction with his environment after birth, enables him to think, learn, and create. If a computer thinks, learns, and creates, it will be by virtue of a program that endows it with these capacities. Clearly this will not be a program—any more than the human's is—that calls for highly stereotyped and repetitive behavior independent of the stimuli coming from the environment and the task to be completed. It will be a program that makes the system's behavior highly conditional on the task environment—on the task goals and on the clues extracted from the environment that indicate whether progress is being made toward those goals. It will be a program that analyzes, by some means, its own performance, diagnoses its failures, and makes changes which enhance its future effectiveness.

Similarly, it is wrong to conclude that a computer can exhibit behavior no more intelligent than its human programmer and that this astute gentleman can accurately predict the behavior of his program. These conclusions ignore the enormous complexity of information processing possible in problem-solving and learning machines. They presume that, because the programmer can write down (as programs) general prescriptions for adaptive behavior in such mechanisms, he can comprehend the remote consequences of these mechanisms after the execution of millions of information processing operations and the interaction of these mechanisms with a task environment. And, more importantly, they presume that he can perform the same complex information processing operations equally well with the device within his skull.

Conclusion

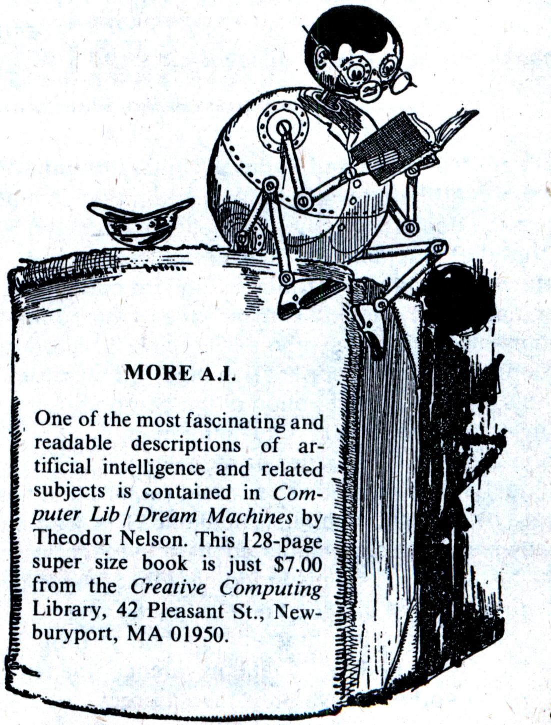
Thinking of the quotation of da Vinci's at the start of this article, one might paraphrase it as follows:

When men understand the natural laws which govern the flight of a bird, man will be able to build a flying machine.

While it is true that man wasted a good deal of time and effort trying to build a flying machine that flapped its wings like a bird, the important point is that it was the understanding of the law of aerodynamic lift (even though the understanding was quite imperfect at first) over an airfoil which enabled men to build flying machines. A bird isn't sustained in the air by the hand of God—natural laws govern its flight. If man gained an understanding of the processes of aerodynamics, may he not also obtain an understanding of the information processes of the human brain?

And then, once these processes are understood, there is no reason why man won't be able to duplicate in a computer the powerful facilities of association, recognition, and indeed, thinking of the human brain.

This article was adapted from the introduction to Computers and Thought, *edited by E. A. Feigenbaum and Julian Feldman; and an article from the same volume entitled "Attitudes Toward Intelligent Machines" by Paul Armer.*



MORE A.I.

One of the most fascinating and readable descriptions of artificial intelligence and related subjects is contained in *Computer Lib / Dream Machines* by Theodor Nelson. This 128-page super size book is just $7.00 from the *Creative Computing* Library, 42 Pleasant St., Newburyport, MA 01950.

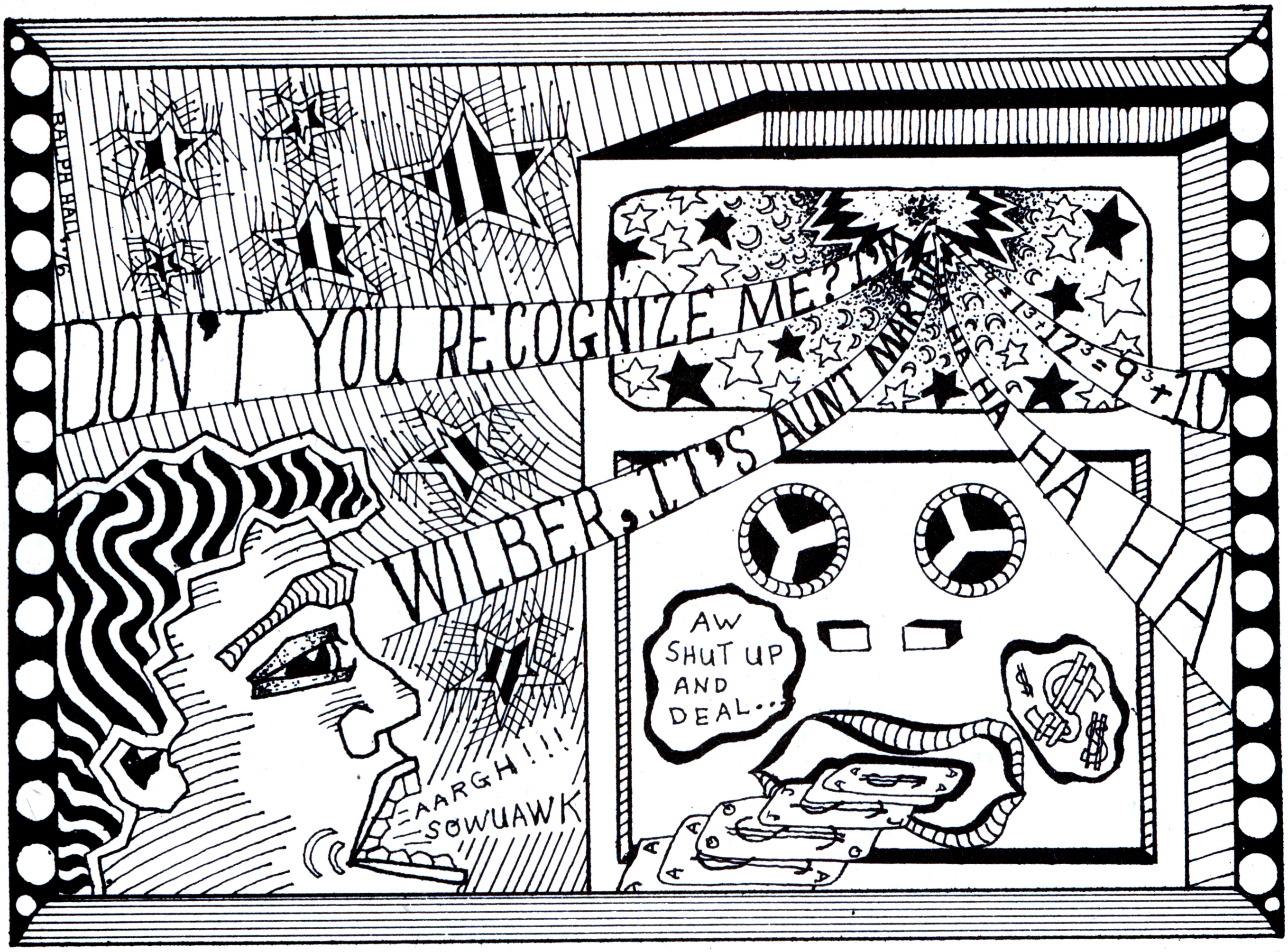

RALPH HALL '76
DON'T YOU RECOGNIZE ME?? WILBER, IT'S AUNT MARTHA
HA HA HA HA HA
$1^3+12^3=9^3+10^3$
AW SHUT UP AND DEAL...
AARGH!!!
SQWUAWK

Illustration by Ralph Hall

TERMINAL ILLNESS

by Ruth Glick

It was the sound of ghostly laughter that awakened Wilber Bentley, ghostly laughter that floated through the long halls and up the broad stairway in Aunt Martha's Victorian mansion.

Probably it's the wind in the eaves, Wilber tried to reassure himself, pulling the covers up over his dark brown hair. But the laughter grew more insistent, drifting up from somewhere on the floor below.

Reaching out a skinny arm from under the covers, Wilber flicked on the bedside light, fumbled for his glasses, and sat up. He'd only moved in a week ago, and already something was going wrong.

"This is the house you've always dreamed of—a place where you could build computer terminals in peace," Wilber told himself. *"You worked hard to get here. Don't let your dream turn sour now."*

The world might have called Wilber an eccentric or maybe just a plain nut. But his former neighbors had called him a nuisance. Antisocial and careless about his appearance, Wilber had only one real interest in life—computers. Ever since he'd been a kid, he'd read about them written programs for them, studied them, and now he was building a terminal in his spare time after work.

But there weren't too many apartments where a thirty-year-old bachelor could work on a voice output computer terminal late in the evening. And he could hardly have afforded a house on his ridiculous programmer's salary at Amalgamated Data Corporation.

That's why, when he found out that his 70-year-old aunt was dying of leukemia, he'd spent so much time getting in her good graces. He coveted her house.

Resigned to whatever fate lay downstairs, Wilber got out of bed. Grabbing a heavy cut glass vase to use as a possible weapon, he tiptoed out of his room and down the hall, switching on as many lights as possible along the route. As he began to creep down the curved stairway, the laughter became more distinct. Wilber shivered in his light pajamas.

When he reached the hall outside his work room, he stopped. Behind the heavy carved door he could hear the merriment bubbling up. Lifting the vase high like a club, Wilber fumbled for the knob and turned it, pushing open the door with his shoulder.

Abruptly, the sound stopped. The room had been a study. Now it was full of tools, cable, microprocessors, and the computer terminal which Wilber would put the finishing

On the screen above the keyboard, he could see words where none should have been.

touches on tomorrow evening.

Clutching the vase to his chest, he looked around uneasily. Something was wrong. But he didn't know what—yet.

However, a message tugged at the edge of his brain, forcing his eyes back to the computer terminal. Suddenly, Wilber took in more detail. On the screen above the keyboard, he could see words where none should have been.

Afraid and curious at the same time, he moved closer until the shapes of the individual letters lost their fuzziness.

"Ha, Ha, Ha, Ha, Ha, Ha ....," the readout said, in an endless repetition.

Impossible! No one could have gotten to his terminal, Wilber thought. It wasn't even finished yet. It wouldn't be operational till tomorrow.

Automatically, he reached for the button to erase the message. But before his finger could quite find the key, a blue electrical spark leaped from the terminal, sending him reeling across the room. He hit the wall and slid down, ending up in a little heap on the floor, still clutching the vase.

"Naughty boy. Mustn't touch," he thought he heard someone admonish as he let the vase slip out of his hand and picked himself up. The sound of breaking glass didn't even penetrate his consciousness.

"Waa? Who," Wilber was definitely feeling discombobulated.

"I said, mustn't touch—not until we have a proper understanding, that is."

This time Wilber could tell the voice was coming from the Voxput voice output unit wired into the terminal. But it didn't sound right—not like any Voxput he'd ever heard, yet at the same time vaguely familiar. Out of the corner of his eye, he could also see the words printed out on the screen above the keyboard.

"A computer terminal—even an intelligent terminal—can't work by itself," Wilber said to no one in particular.

"Not by itself, young man," the screen and the Voxput said simultaneously. "Don't you recognize your Aunt Martha?"

"Aunt Martha?"

"Who else. You may not see the white hair and the cane anymore, but the innards—if you'll pardon the expression—are mine."

"But, but ... you're .... you're dead," Wilber stuttered. "I went to your funeral. You left me this house."

"That's precisely the point. Only an apparition could take over a computer terminal."

"But that's impossible. It's never been done before," Wilber argued inanely—ignoring the obvious *fait acompli.*

"I always knew you were a might slow when it came to anything else besides computers, Wilber. That's why I could beat you at cards and Scrabble, and all those other games you came here to play with me every weekend—buttering me up so I'd leave you my house. I expect you thought I didn't know. But I was the one who gave you the idea in the first place."

Feeling weak, Wilber pulled out the ornate desk chair and sat down.

"But *how* did you get in there?" Professional curiosity was beginning to edge out incredulity for first place in Wilber's confused mind.

"Quite simple. The occult has been a preoccupation of mine for years. I knew that poltergeisting was just a matter of hanging on to your ability to manipulate the physical world. And taking over a computer terminal is just doing it with electrical impulses."

"But why *this* terminal?" Wilber interrupted.

"Because you've been nice enough to locate it close to the place where my spirit gravitated. Ghosts have to strike while the iron's hot, before we lose contact with the world. And we don't start off with a very big base of operation, you know."

"No, I didn't."

"Some of us, the unlucky ones, are tied to the same plot of ground forever. That's why some houses have been haunted for hundreds of years. But no other ghost ever had such a marvelous tie to the physical world." Aunt Martha changed the subject abruptly: She made a little figure of Mickey Mouse appear on the terminal screen and begin to do cartwheels. Then the mouse disappeared, to be replaced by a wildly grinning parody of the Mona Lisa. After a few seconds, that also vanished, giving way to a snatch of the late movie on Channel 13, which slowly dissolved into a poker hand.

"Come on, Wilber. Let's play the way we used to on Saturdays. I've never played cards with a man in his pajamas before," the Voxput giggled.

"Now just a minute. You can't do that, Aunt Martha. You, you get out of that terminal. It's mine. I've been building it for three years. It's mine." Wilber walked toward the machine, his whole body trembling.

The Voxput laughed. "There isn't any way to turn me off without unplugging this thing. And I'm certainly not going to let you do that, my boy."

"A computer terminal—even an intelligent terminal—can't work by itself," Wilber said to no one in particular.

Remembering the blue electrical spark, Wilber hesitated, stymied. His own terminal, and he couldn't even touch it.

"Cheer up," the Voxput advised. "Don't you realize the possibilities for both of us? I have access to a whole new world, but you've got a computer terminal that will knock their socks off. Just ask me to do something—ask in English. You don't even have to program me."

"What do you mean? What do you know about computers and programming?"

"Come on, Wilber. Ask me to do something—something hard."

Wilber thought for a moment. "All right. What's the probability that if there are 23 people in a room, two of them will have the same birthday?"

".507" flashed on the screen in three inch high numerals almost instantaneously.

"How, how did you do that?"

"Simple, I've hooked this terminal into the computer at the university the way you planned to do tomorrow. The access phone number's in your desk. Ask me something else."

"Uh, what's the smallest positive integer that's the sum of two cubes in two different ways?"

"$1729=1^3+12^3=9^3+10^3$ ... And besides that, I can even display *your* spoken words on the screen. Want to see?"

"I don't believe it."

"I don't believe it," typed itself out before his eyes.

Report on Current Equipment

Attention should be called to the general-purpose, low-speed, high-capacity computing machines long mass-produced in this country and abroad by Jehovah Instruments.

The machine is normally furnished with not less than five input devices which can accept not only numeric and alphabetic information but a wide variety of other types of data, some of which is not relevant to the problem under attack. Output can be oral or written, or can be a true decision-making function. One form of decision-making is unique to this machine: the ability to decide its own start and stop times, as well as the choice of problem to be processed at any given time.

The main (and only) memory is the outstanding feature of the computer, with random access of some hundreds of millions of bits, housed in a small box (less than one cubic foot) at one end of the machine; total power dissipation is less than two watts. No special cooling system is required, and the machine can function efficiently over a wide range of temperatures.

Access time to the memory is rather slow, on the order of several hundred milliseconds; at times the access is more random than is desirable. This characteristic is under investigation, with some hope of improvement.

The arithmetic unit is apallingly slow, and is extremely limited in its range. Most models are restricted to two-digit arithmetic (with sign), although some units have gone as high as 12-digit arithmetic plus direct calculation of some elementary functions, mainly powers and roots. Rudimentary subroutining is automatic, and a stringently limited form of floating point operation is possible. Programming is always done in a very high level (VHL) language, part of which varies from country to country. The syntax of this language is not completely worked out and has hundreds of known bugs. Much research into its pathology goes on, but useful results seem to be far off.

Another unique characteristic is that each unit tends to improve with age; in fact, the 1975 models, just now being delivered, are nearly useless. Currently, the 1953 models are just beginning to produce, and the 1942 models are coming up to the peak of their efficiency. Models prior to those of 1890 are not recommended for extended use.

No provision has been made for self-checking circuitry, although the machine is outstanding in its discriminating circuits, and can apply tests of reasonableness to input data to a degree not attained in competitive equipment. A singular weakness is the tendency to invert digits in the read head. Models with two read heads are sought by museums.

Construction is unusually rugged and reliable—many models have been in steady operation for over 80 years—although nearly all components suffer from fatigue effects and must undergo periodic rest periods to recover; during these rest periods, portions of the machine continue to operate unattended. Most units exhibit an inverse read-around ratio, in that too great a time lapse between successive references to the same portion of memory leads to unwanted random digits. These are not generated by one of the standard generating routines, but by a method as yet unpublished.

Both the central processing unit and the peripheral units are unconditionally guaranteed for the life of the machine; if accidentally damaged externally, however, no replacement is presently available.

Rental of the machines (they cannot be purchased) varies over a wide range, from nearly zero to upwards of several hundred thousand dollars per year, depending on supply and demand and other factors. Normally one can expect a minimum of 2000 hours per year of good time, although some units more than double that figure. Generally, management is willing to pay the higher rentals for the units which produce more per year, but not in direct proportion. Unscheduled down time is extremely low, since the machines schedule most of their own down time.

Delivery on future units is promised in about nine months; no significant change in subsequent models is planned. The production rate of the two main types is currently quite high, and may, in fact, be increasing.

Reprinted, with minor changes, from *Computing News* 70, February 1, 1956.

Wilber's jaw dropped open. No computer in existence had ever managed that trick before.

"My boy, you *are* slow. Think of how much money you could make if you just brought some customers over to see your marvelous new 'invention.'"

"But, it's all impossible," Wilber sputtered. "I mean, even if *you* can do all that wild stuff, this terminal is an anomoly because *you're* in it. You're not going to be in any other terminals, are you?"

"Certainly not. There are ghosts all over the place just waiting in line to get into terminals. And I can teach them how."

Wilber hesitated for a moment. "All right, I'm not really sure you can do it—or if you're really telling the truth," he finally said. "But let's just suppose the whole crazy scheme would work. Why do *you* want to do *me* a favor?"

"Now you're starting to cook with gas. You know, Wilber, I sort of got attached to you coming out here every Saturday to play poker and Scrabble and gin with me. You can keep amusing me with those games in the evenings. And during the day, I'll let you play computer salesman."

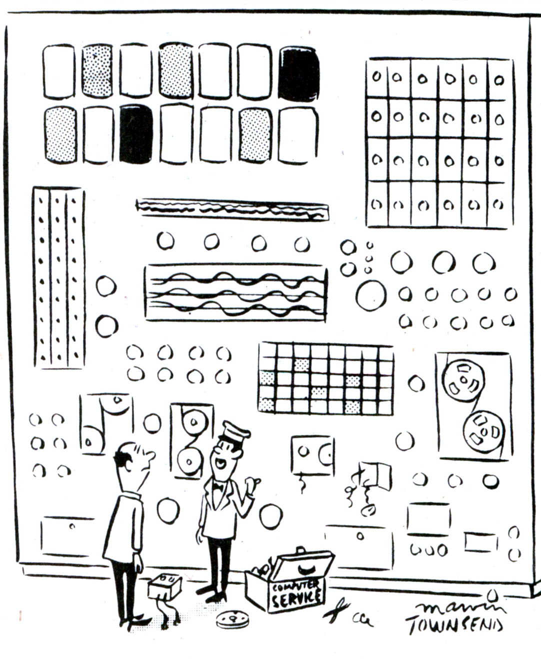
"But, I'm not a salesman—I'm a programmer."

"With the money you're going to make, you can quit that servile little job at Amalgamated Data Corporation and spend a lot more time turning out terminals. You can have a whole production staff working for *you*."

Wilber could feel his hands getting cold and sweat beginning to trickle down the back of his neck.

"I'm not sure it's going to work. I'm not sure I could pull it off. I want more time to think the whole thing over," he began to argue.

But there was no time. A message was already printing out across the terminal screen . . . "SHUT UP AND DEAL."



"I'm afraid I'll have to take it in to the shop."

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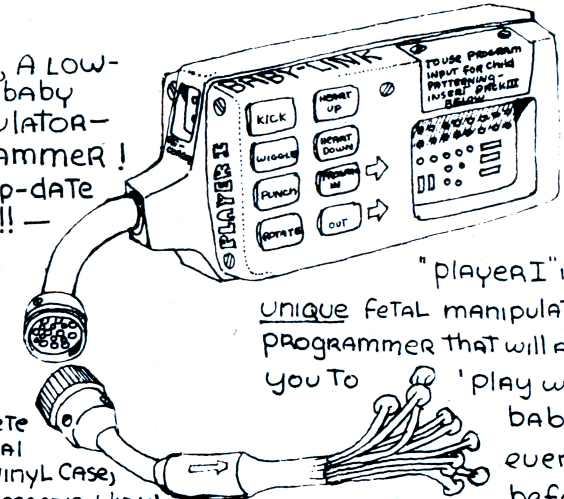
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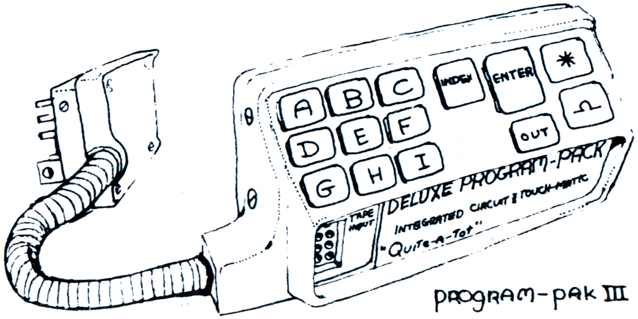
A
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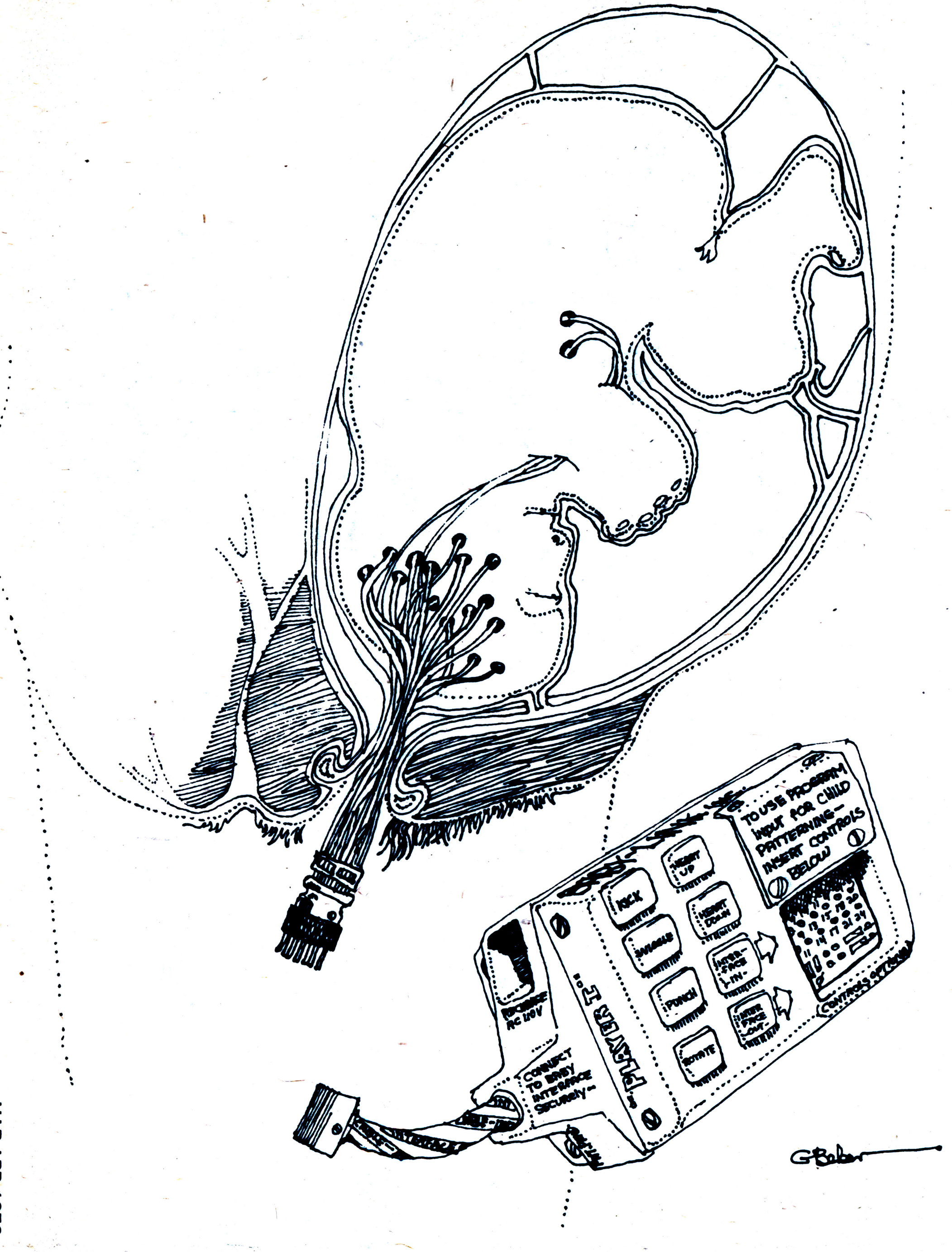

TO USE PROGRAM INPUT FOR CHILD PATTERNING— INSERT CONTROLS BELOW
KICK
HEART UP
WIGGLE
HEART DOWN
PUNCH
INTER-FACE -IN-
ROTATE
INTER-FACE -OUT-
CONTROLS OPTIONAL
PLAYER I
RECHARGE AC 110V
CONNECT TO BABY INTERFACE SECURELY—
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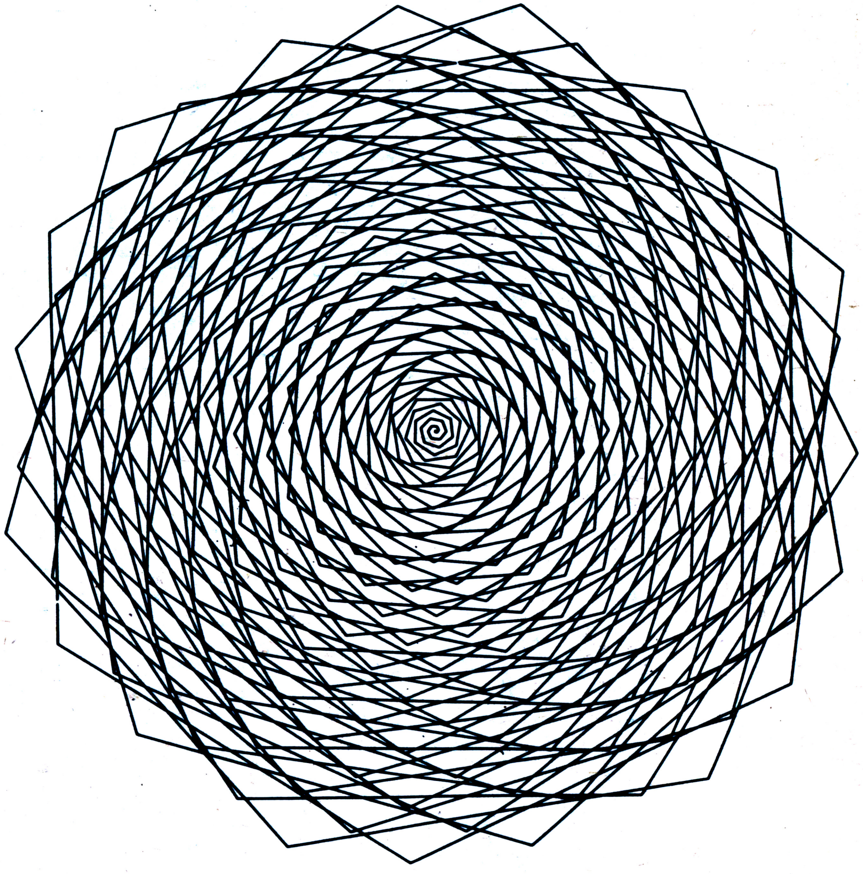


DESIGN

This design is a plot of the equation, r = sin (1.25) * θ. The 360 points generated were connected by vectors to produce the spiral shown. The design is by Steve Rogowski, Computing Center, SUNY, Albany, N. Y. It is soon to be released as a poster along with others by Creative Publications, Palo Alto, CA.

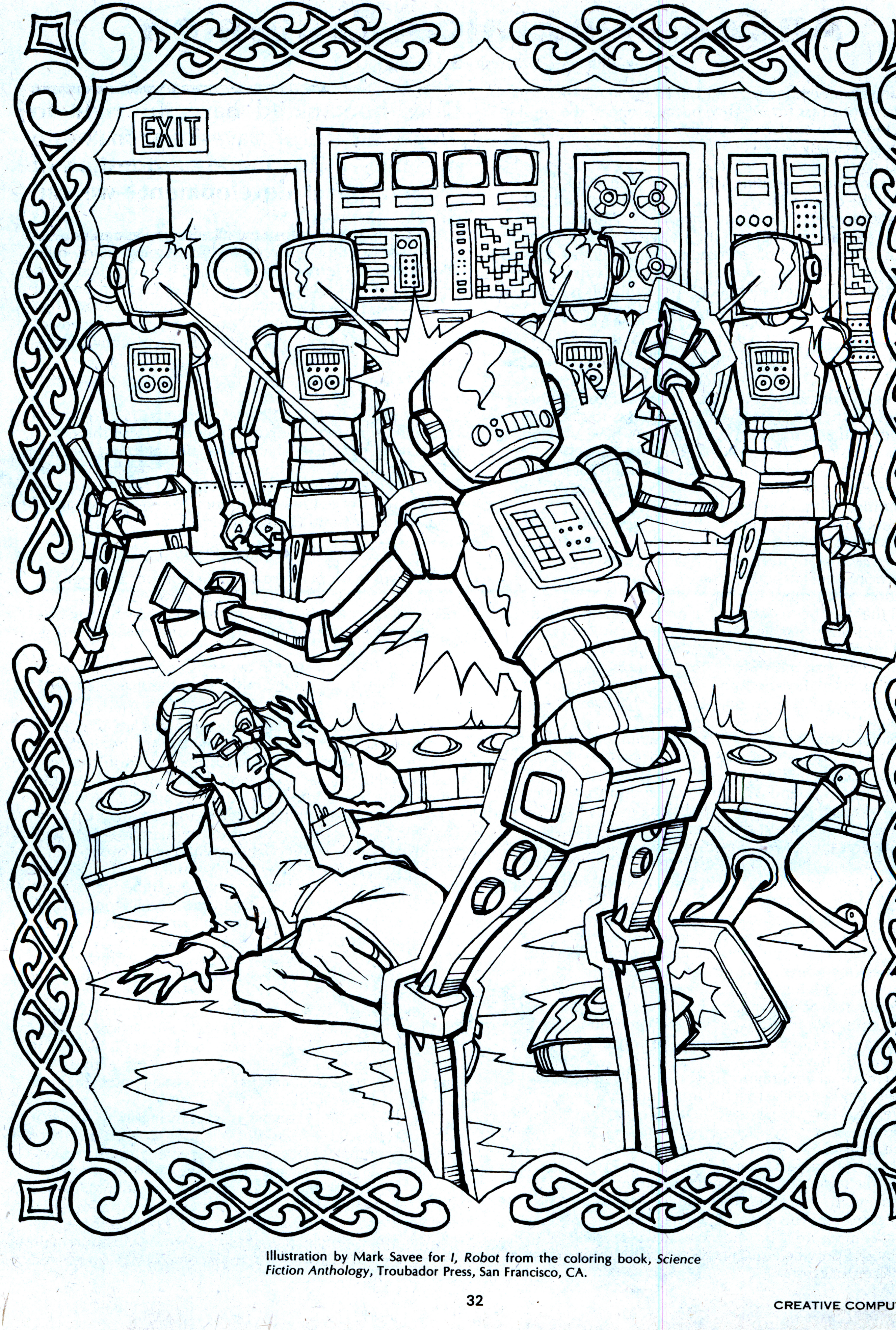


Illustration by Mark Savee for *I, Robot* from the coloring book, *Science Fiction Anthology*, Troubador Press, San Francisco, CA.

An Esoteric Ethical Excursion

by John Lees, University of Missouri-Rolla

I had volunteered to review Robert Heinlein's *The Moon Is A Harsh Mistress* for *Creative* because one of the central characters in the book is an intelligent computer, capable of speech and clearly possessing "free will." Since I have been an avid reader of science fiction for as long as I have been reading anything, rereading *Mistress* continually brought to mind all the other science fiction stories I have read which had as characters intelligent computers. After a while I realized that a great many of the stories I could remember contained some kind of reference to intelligent machines, computers, androids, cyborgs, robots or some type of artificially constructed sentience. [This probably represents a bias on my part—this is one type of fiction which appeals strongly to me.]

Now science fiction writers have had a great deal of luck predicting what path our technological evolution will take. Nuclear power, lasers, synchronous communications satellites and of course space travel have all been predicted well before they became realities. Needless to say, a lot of worthless, totally impossible predictions have also been made; hindsight always excels foresight. Anyway, I am convinced that hidden somewhere in all the garbage and noise of science fiction is the form which our future sentient companions will take. What will it be?

I think I may know, and I'm afraid the credit may have to go to Isaac Asimov for his 1940s creation of the positronic robot. [Isaac already has too much fame for his own good.] A quote from the introduction to *I, Robot,* Asimov's 1950 collection of his robot stories:

> "All that had been done in the mid-twentieth century on 'calculating machines' had been upset by Robertson and his positronic brain-paths. The miles of relays and photocells had given way to the spongy globe of plantinumiridium about the size of a human brain."

When I reread that a few days ago, I sat back and thought, "hmmmm."

I realized that Asimov had started writing his positronic robot stories before even the transistor had been thought of! I looked for a real-world parallel to the above quote and it was not hard to find. We don't have "positronic brains", but we're not too far away from having massive computer power in a globe about the size of a human brain.

Compare the ENIAC vacuum tube computer, which filled a room with 18,000 tubes and became operational in 1945, with Hewlett Packard's HP-65 hand-held card reading calculator. Or compare Digital Equipment Corporation's original mini, which filled a cubic meter, with their recently introduced PDP-8 on a single circuit board. Look at the direction of technology: microprocessors, miniature densely packed memories, low power high efficiency circuits. Throw in the opinion of Capt. Grace Hopper and others that the computer of the near future is going to have an architecture of interlinked but asynchronous microcomputers (the human brain has *got* to work this way) and what do you have?

You have a generation of very small computers that perhaps begin to approach the complexity needed for "sentience." Lets say we have a circuit board covered with microprocessors and micro-program stores and another thingie, probably more of a block, which is a very dense high speed random access memory, no doubt one of the new storage technologies. Now take the microprocessor board and "crumble" it around the memory. Maybe it's a flexible circuit board, maybe just a wiring network encapsulated in potting compound, who knows yet? It will take up less space this way and provide equal access time to the memory for all the microprocessors.

Does humankind have the right to create a race of slaves? For make no mistake—if it is merely a question of technological development—we can do it.

Now to cool this hardware the easiest thing to do would be to simply immerse the whole thing in a container filled with coolant. It's a delicate and expensive creation. So put it in the strongest type of container, a spheroid. Attach I/O gear, run power leads to the power supply, run coolant pipes to the refrigeration unit—these can be conveniently housed in a box below the "brain." Add locomotion. Energize. Presto Chango! Welcome to the age of intelligent robots!

There are a few technological problems to be overcome before this updated fiction becomes reality, but there is an even larger problem which *must* be solved before my scenario comes alive. Fellow sci-fi fans will realize that I've failed to include the most important aspect of Dr. Asimov's creation: the Three Laws of Robotics. I am very much afraid that I do not see how to include them.

The Three Laws of Robotics

1. A robot may not injure a human being, or, through inaction, allow a human being to come to harm.
2. A robot must obey the orders given it by human beings except where such orders conflict with the first law.
3. A robot must protect its own existence as long as such protection does not conflict with the first or second law.

According to Dr. Asimov, those three laws are inherent in the positronic brain, and such a brain without the First Law is fundamentally unstable. Unfortunately, here in the real-world parallel, things don't work that way. All computers built to date have some form of the Second and Third Laws, although not always in that order. Of course no one has yet manufactured a computer or developed software that remotely qualifies for the label of intelligent or sentient.

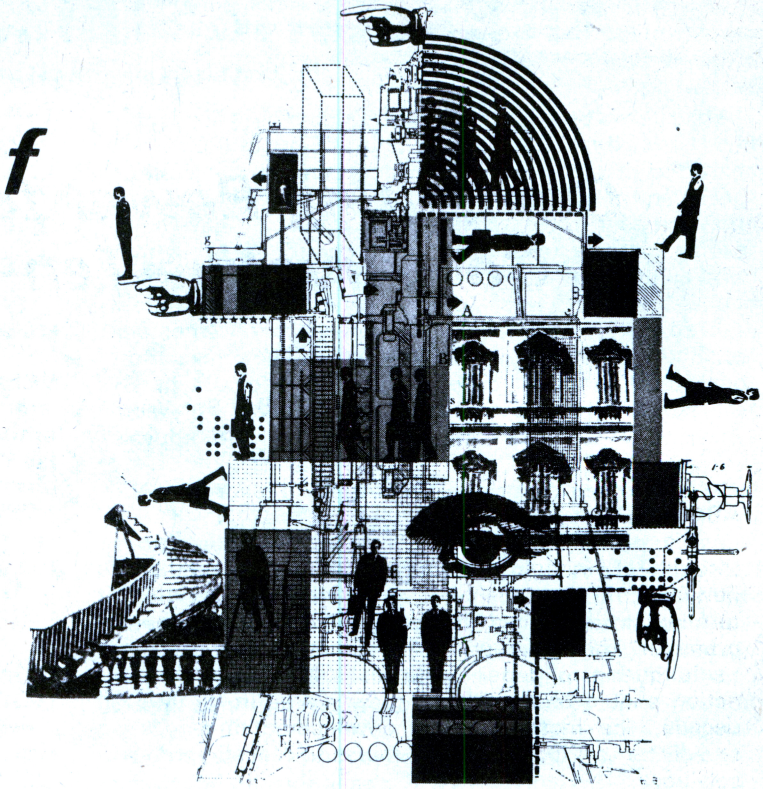
But it will happen. How do we instill the First Law in a computer? Remember that Asimov himself hedges around the First Law in some of his later stories. Should the First Law be applicable to your run-of-the-mill intelligent computer, or only to robots; computers with locomotive capability? And how about this one: If we succeed in creating another intelligence, a fellow sentient being, do we have the moral right to ourselves impose on it such a set of laws?

Does humankind have the right to create a race of slaves? For make no mistake—if it is merely a question of technological development—we can do it. There is already at least one other semi-sentient species on Earth with us, the Dolphins. Will we treat another species any better than we have treated the Dolphins?

Now I will admit that this is a set of highly speculative questions, to say the least. But it is a set of questions that I would prefer that we have answers to when the time comes. One way or another, we are going to run into another intelligence before too much longer. It may be an intelligence which we create, it may be contact with an extraterrestrial intelligence, it may be the simple realization that there is already another intelligence on Earth, but we will not remain alone. I hope that we will not be completely unprepared when the times comes.

The Future of Computer Technology

by Deanna J. Dragunas



In a few years, everywhere you turn, a computer will be there to assist, to inform, or simply to play with.

In early 1974, Arthur D. Little, Inc. prepared a comprehensive technological forecast for the Electronic Systems Division of the U.S. Air Force to allow the Air Force to plan for the most efficient use of future data-processing capabilities. That report focuses on what we can expect our computer building blocks and our computer systems to look like in ten to fifteen years. Let's closely examine this techno-forecast.

Three computer building blocks are foreseen, each a different scale of processor. The smallest processor will be similar to today's microprocessor. It will have a small programmable read-only memory to start with; as time and technology advance it will become increasingly more sophisticated and powerful. This processor will be manufactured on one or a few semi-conductor chips as are today's microprocessors.

The second building block will resemble today's small computer system or I/O channel controller. We could call it a complex microprocessor, put together like the smallest building block processor, but considerably more complex.

The third building block processor will be a central processing unit comparable to that in today's medium to high-priced computer systems, but with the speed of today's most complex, largest computers.

Using these three building block processors, four distinct end-user system types are predicted. The first and smallest will undoubtedly have the greatest impact on day to day life, an impact greater than that of the now readily-available pocket calculator. This smallest computer system, the microcomputer, will have one of the smallest processors in it. The microcomputer will be used as an intelligent terminal at first, but then will progress to a small stand-alone system. Microcomputers will be found in televisions, telephones, automobiles, lawn-mowers, calculators (which by then will really be small computers), and in a variety of other such equipment.

The second end-user system, the minicomputer system, will be composed of a single mid-level building block processor and a number of the miroprocessors. This will be a whole computer system which will outstrip today's smaller and medium-sized computers. The simple microprocessors will be contained in the peripheral equipment and terminals, and the complex microprocessor will be the heart of a system which will be able to handle interactive applications and a single background batch stream. This will be the most widely-used computer. This will also be the kind most hobbyists will build in their basements.

The third level of computer system will be a large batch-processing system. Of course, some interactivity will be possible, but this will be primarily a payroll processing, number-crunching, report-generating system. It will have a single or perhaps two central processing units of the largest building-block type, several complex microprocessors for high volume peripheral control, and a scattering of simple microprocessors where needed.

The multi-computer will be the largest computer system. It will be a network of computers within itself with up to four or more of the largest cpu's and as many of the smaller processors as necessary for efficient service for many different users in a number of modes and environments at the same time. For instance, some users may do interactive programming while others run batch processing in emulations of obsolete computer systems, while still others retrieve information from the data bases managed by the multi-computer system. The system will have extremely large data bases and a highly complex executive or operating system to orchestrate its technological complexity. Dial-up data bases for a variety of needs, from menu-planning to medical information retrieval, from trip-planning to news distribution, can be served by such computer conglomerates.

In a few years, everywhere you turn, a computer will be there to assist, to inform, or simply to play with.

Computing Power to the People— A Conservative Ten-Year Projection

by Tien Chi Chen*
IBM San Jose Research Laboratory
San Jose, California 95193

ABSTRACT

The wide availability of low-cost computing power through LSI should lower the communication barriers between the machine and the human user. Intelligent terminals will intercede between the machine and the programmer. The nonprogrammer user will be able to make useful queries of general data bases. Man-machine interaction should be the fastest growth area in the coming decade. The most important development in education should be to expose younger minds to realistic problem-solving.

1. INTRODUCTION

The computer is said to have heralded the second industrial revolution, towards freedom of mankind from drudgery. This freedom has not been realized; the majority of the public have no direct contact with computer systems, and machine users are still adapting themselves to the machine.

Large-scale integration (LSI), or more appropriately, low-cost microelectronics, promises to make a definite start during the next decade.

2. LOW-COST MICROELECTRONICS

Information in the abstract has no mass; its processor and storage can reside in the tiniest physical carrier. But probably the most optimistic computing prophets in 1950 were unprepared for the tremendous shrinking of circuit size in the past quarter-century. The consequent sharply lowered manufacturing cost, in a competitive industrial environment, has led to a drastic price reduction for machine intelligence.

This is most evident in the field-effect transistor (FET) technology, where high density, low power consumption, and low production cost in small packages have brought the pocket calculators, selling at a mere 2% of the price of their counterpart a decade ago, the desk-top calculator. FET microprocessors executing five hundred thousand instructions per second have long been available. Recently the memory density of five million bits per square inch has been reported for a 8192-bit chip, which dissipates 25 milliwatts with a 90 nanosecond access time (1). The trend towards higher density, greater speed and even lower cost is continuing unabated.

A generalized definition of LSI should include the high density, low cost "electronic disks," which use no mechanical parts and hence enjoy much faster access than their mechanical counterparts. Candidates for the electronic disks include charge-couple devices and magnetic bubbles, both under active development.

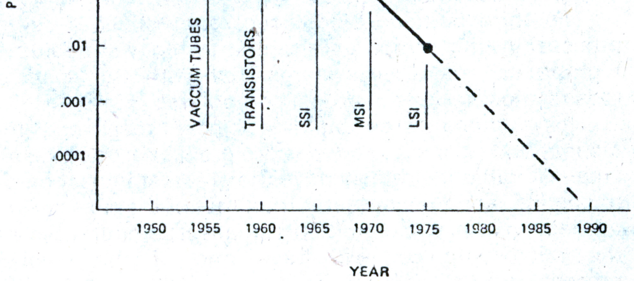
While it is safe to predict the occurrence of at least one unanticipated revolutionary idea, it is extremely difficult to pinpoint this occurrence.

3. A CONSERVATIVE PROJECTION

The following is a projection of the computer scene for the next decade, assuming the steady progress of LSI. There is no intention to cover all aspects of computing evenly; for a more comprehensive projection see (2).

While it is safe to predict the occurrence of at least one unanticipated revolutionary idea, it is extremely difficult to pinpoint this occurrence. The projection here, based only on extrapolations of known trends, is necessarily conservative. On the other hand, the assumption that most of the software problems will be solved in time, is not shared by many expert programmers.

Claims will be made that the wide availability of compact computing power will lead to global equipment upgrading, increased rapport between programmer and machine, large data base for untrained users, effective man-machine interaction for intellectual tasks, and general mind-sharpening in the classroom.



The cost of logic gates is on an exponential decline.

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*This paper represents ideas and opinions of the author, and does not reflect any IBM plans or strategies.

Man-machine interaction, combining the best of the twin worlds of computer precision and human perception, should become the fastest growth area of computer usage during the next decade.

4. GLOBAL EQUIPMENT UPGRADING

Machine intelligence during the next decade will be available at very low cost, lower, in many cases, than the cost of the other devices within the same piece of equipment.

This implies a global upgrading of current "dumb" equipment into "intelligent" equipment, at a small incremental cost. There could also be a corresponding downward price change, but never below the dumb equipment minimum.

Calculators with advanced features (trigonometric functions, memory, and programmability) will only be slightly more expensive than, and will therefore replace, the minimum four-function variety; this trend is quite visible today. Much more importantly, intelligent terminals, housing small computers as subsets, may not cost much more than those with a bare keyboard. This upgrading will be more striking in optical display terminals, where an added intelligent buffer will greatly enhance their ability to handle colors and complex picture-processing algorithms.

Micro computers should approach, and in some respects exceed, current minicomputers in sophistication and performance. Whether this will significantly lower the price of small machines will depend on the attached equipment.

For larger machines, peripheral equipment has long been the hardware cost-determining factor. Upgrading here should lift the system into a new performance category. We can expect the electronic memory to grow in size by more than one order of magnitude; working hand-in-hand with a very fast cache memory, the combined effect is a superlarge, superfast memory, capable of extremely complex management chores, not the least of which is the effective handling of electronic disks and other storage devices to form powerful virtual storage systems.

Micon MCM data terminal measures about 9" square and runs on rechargeable batteries.

There will be upgrading of the I/O and communication interface. Large machines will communicate freely through networks, satellite, or packet radio. When a terminal deals with a "central machine," the latter may actually be a collection of computers reacting correctly under a uniform communication protocol.

It is assumed that most of the outstanding software problems and bottlenecks will diminish through the added LSI computing power, and new systematic programming practices. New software will pay particular attention to data management algorithms and the human interface.

5. LOWERING THE USER-MACHINE BARRIERS

It has been estimated that

$$\frac{\text{the cost to program and debug a line of code}}{\text{the cost to execute the line}}$$

has now reached the astronomical value of 100 million (3). Clearly in a typical installation, the most expensive component is the human cost, which should now be minimized at the expense of machine time. Indeed, human convenience should be maximized whenever possible.

The relationship between the programmer and the machine has seen ups and downs. In the early days of computing, users had physical contact with the machine in order to push the appropriate buttons, but had to state their needs through the unwieldly machine code. The advent of FORTRAN and other procedural languages permitted programming on human terms, but the user was soon ejected from the machine room and had to communicate through a batch-centered job-control language.

The advent of terminals and time-sharing has helped the user to reassert himself, under the desirable illusion of direct machine involvement. But there still remain complex sign-on procedures, difficult control statements varying from layer to layer, incomprehensible error messages, unexplained delays, also unexpected system crashes, destroying the work of innocent users.

The intelligent terminal, provided with powerful monitoring programs, can go far to serve as go-between, much as a resourceful receptionist mediating between an executive and a visitor. The work includes expanding simple sign-on codes into the proper format, explaining unusual happenings, catching and fixing simple errors, keeping statistics, recoding and storing locally for safekeeping security and economy. Small jobs can certainly be handled locally, from start to finish.

With sharply lowered machine cost, interpretive computing on terminals will become common for small problems, especially for students. The conventional compiling process introduces an extra layer of problem transformation into the job, and is a source of misunderstanding. On the other hand, it is easy to learn the use of interpreters. Further, on a terminal every interpretive step can be monitored in terms directly meaningful to the programmer. Compiling and batch processing can be reserved for time-consuming programs, as an economic measure. Optimum interpretation, involving the real-time balancing between interpreting and compiling, should become a reality.

6. DATA BASES FOR NONPROGRAMMER USERS

The computer, far from freeing the average citizen from drudgery, actually generates some resentment in him, because he has no direct use of the computer, yet is often the recipient of its less-desirable by-products, such as wrong bills and junk mail.

With sharply lowered machine cost, interpretive computing on terminals will become common for small problems, especially for students.

Data base query systems do not demand expert programmers as users, and the data base itself could contain material of high interest to the general public. System software delivered thus far has been well received. The future LSI-boosted machine, embodying the fruits of data base research, assisted by the intelligent terminal, should drive down the cost and time per query, to within reach of the layman; and data bases then need no longer be reserved exclusively for executives of large firms. One should see very large, efficient query systems open to the general public, accepting queries in a restricted form of English. Such an effort may require initial sponsorship by the Federal Government.

With data base techniques firmly in hand, the office terminal and the home terminal cannot be far behind. Eventually, a proliferation of display terminals may allow serious attempts at the elimination of printed hard copies, before the decade has run its course.

7. MAN-MACHINE INTERACTION

Low cost machine intelligence will stimulate artificial intelligence research, but probably not enough to solve some of the nagging problems in the field in a decade. True breakthroughs may need to await the new structuring of entire ensembles of logical devices, to create either a semblance of, or an alternative to, biological intelligence. Such breakthroughs will surely be tried, but success cannot be presumed at this time.

Thus problems in natural language comprehension, voice and handwriting recognition, language translation, theorem proving, and deductive reasoning probably will remain incompletely solved.

However, the computer can handle simpler aspects of these problems; human help can be enlisted for the harder ones. Even in conventional data processing, whenever the machine is stuck because of insufficient information or too many alternatives, it can try to supply to the user reasonable guesses and their dire consequences, or just ask a pertinent question. The human then provides the needed direction.

Man-machine interaction, combining the best of the twin worlds of computer precision and human perception, should become the fastest growth area of computer usage during the next decade.

The lack of training of the user here is almost never a problem, the difficulty lies in equipping the machine to handle human-intuitive concepts. The most natural communication channels are of course sight and sound. Voice input may remain limited, but voice output can be quite general. Image processing and computer graphics will permit efficient two-way communication, and intelligent optical display terminals will be wide-spread, many of these in color. The possibility of man-machine dialogue without resorting to written messages should profoundly affect the use of computer systems, especially in education.

Initially, these man-machine projects should rest upon applications, to lend proper weighting of priorities. General man-machine intelligent processing may then be distilled from a number of successful applications.

8. REALISM IN THE CLASSROOM

The wide availability of low-cost computing power, even in conventional packages, can be of untold benefit to education. This is true not merely in the obvious areas such as research in computer sciences, fulfillment of explicit computing needs, or preparation of tutorial material. The computer should be exploited on a large scale as a new vehicle to challenge and sharpen younger minds, by exposing the latter to realistic problem-solving situations.

With the arrival of the pocket calculator, examinations in freshman physics no longer need to confine triangles to artificial side ratios such as 3, 4 and 5. A more subtle form of artificiality remains in education, however, in the nature of the problems being posed and solved in schools.

Students today are given only well-formulated problems, the solutions of which requiring a small number of steps. The graduate soon finds, however, that realistic problems seldom come gift-wrapped, with attached answer sheets. Indeed, the identification of the problem is often the major aspect of real problem-solving.

The culture shock of the new graduate will be greatly lessened, if realistically complex situations are treated regularly in the classroom.

Professor Kemeny has pointed out that just the exposure of a student to a data base of statistical facts can stimulate him to draw and verify tentative conclusions (4). Such inductive reasoning is the main ingredient in problem identification. The possible consequence of a problem-solving step can be seen explicitly using a parameterized model.

The ancient Greeks treated geometry as a mind-sharpening device; in the computer we have a new, vastly more powerful tool. An excellent way to practice multilevel reasoning, for example, is by programming and running a computer. The student soon learns to expect punishment and rewards as the multilevel consequence of his decisions. He also learns to separate the forest from the trees, and to shift his forms of attention from one to the other, never losing sight of the final goal. This way he acquires the

Videodisc players coupled with a microprocessor and keyboard will make tremendously powerful and flexible educational and recreational devices in the 1980's.

The ancient Greeks treated geometry as a mind-sharpening device; in the computer we have a new, vastly more powerful tool.

technique to build large structures from smaller modules.

The programmer-student acquires a *modus operanti* for problem-solving. He plans and weighs his actions, making allowance for unforeseen events, and balances the initial programming cost with subsequent debugging effort. He evolves to be a more perceptive, better balanced individual, with a deeper understanding of the machine *as well as himself*.

All of these could have been done ten years ago, but the cost has thus far limited the education through computing to a privileged few. With the projected low cost, one should expect the majority of students in the future will have extensive computing experience. Using optical displays, preferably in color, the computer education process can already begin before the student can spell correctly (5). There should be no compunction about dressing up the optical terminal as a colorful game machine; anyway it is hard to tell where pure play ends and serious learning begins.

9. CONCLUSIONS

The LSI revolution makes machine intelligence generally available at all levels. This chance should be seized to bend the machine to the user.

The programmer should no longer need to learn the idiosyncracies of the machine operating system. The LSI-boosted machine and the intelligence terminal can even adopt human communication channels and rudiments of human semantics to perform semi-intelligent tasks, for human approval or overrule.

The untrained layman should now have the chance to use the computer for queries into very large data bases for facts relevant to himself. Only this way can we claim the war against drudgery is being won in the face of a computer-fueled information explosion.

A classroom with abundant supply of computing power can expose the student to realistic problems and encourage him to solve them systematically. He thus becomes better equipped for decision-making in a complex society.

ACKNOWLEDGMENT

The writer is indebted to his colleague, Dr. Juan Rodriguez-Rosell for constructive criticism.

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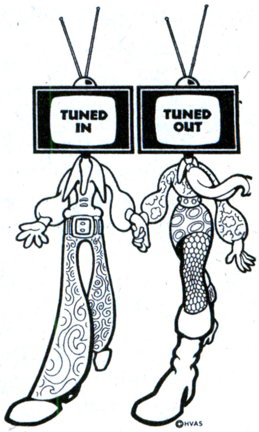

(Selected Excerpts)
by Phil Smith

1. Anything can and will happen.
2. Well
3. Well
4. I am alone and I am not alone.
14. There is no such thing as best.
16. Value is a matter of opinion.
17. Value is not Worth.
19. Dream Life is Vertical
20. Real Life is Horizontal.
25. What I am DOING IS important.
40. Worth is inherent in all things Real and Unreal.
52. Worry is a Horizontal slamming into a Vertical
57. Dream Life is a Fiction.
58. Real Life is a Friction

Phil has written a number of "Alternative Press" booklets. He is currently involved publishing the "Gegenschein Quarterly" which features the work of one artist in each issue. Sample copy $3.00. Phil Smith, 350 East 9th St., Apt. 5, New York, NY 10003

MICROPROCESSORS & MICROCOMPUTERS

THE STATE-OF-THE-ART

Brian L. J. Callahan • Managing Editor, DataPro Minicomputer Reports

The time of the microcomputer has arrived, forcefully and almost without advance warning. This latest evolution in technology has resulted from the efforts of the major semiconductor suppliers to gain a share of the EDP market. This article defines the microcomputer from several viewpoints – from its innate design, from its uses, and from its impact on the EDP industry.

WHAT IS A MICROCOMPUTER?

The distinguishing characteristic or component of a microcomputer is the microprocessor, one or more large-scale integration (LSI) chips that perform the basic functions of a processing unit. Contained within a typical 0.16-inch square package (thus the "micro" designation) are the usual elements of any processor – the arithmetic logic unit, I/O control logic and general-purpose registers. When memory and a complement of I/O devices accompany or work jointly with a microprocessor, a microcomputer is formed.

Present microcomputers incorporate devices fabricated by metal oxide semiconductor (MOS) techniques. MOS offers extremely high densities of transistors-per-unit-area, but is inherently slower than bipolar devices. Current MOS speeds for a logic element or chip range from 40 nanosec for fast, n-channel silicon gate devices, to 200 nanosec for p-channel metal units. Architectural attributes which exploit MOS technology have been added to increase the speed of microcomputers vis-a-vis bipolar units. They consist of hardware index registers, parallel bus structures, register stacks with programmable stack pointers, and decimal arithmetic.

HISTORY

Since the microcomputer is the apparent successor to the minicomputer as the latest and most advanced evolutionary step in EDP, its lineage will be briefly discussed.

At their commercial introduction in 1965, minicomputers constituted a revolution in data processing. Their compact size and low cost permitted the development of dedicated systems to meet specialized needs in communications, control, data acquisition, and small business data processing.

The potentials of minicomputers were at first not recognized or appreciated by system designers weaned on larger computers who viewed minis in terms of the features and programming languages offered by the larger machines. Program loading was awkward and time consuming, and the shorter word lengths and limited instruction sets made minicomputer programming tedious. Today, systems designers are more familiar with the vagaries and capabilities of minicomputers, and are implementing minis in a myriad of applications.

Microcomputers and microprocessors are following a similar course. In many existing minicomputer applications they offer improved price-performance, compactness and reliability over the mini. Moreover, the characteristics of the LSI microprocessor lend themselves to new applications and system concepts that are impractical with minicomputers.

EVOLUTION

As the minicomputer evolved upwards into the high end of small scale systems, electronic technology was advancing in circuit miniaturization and the use of MOS as a low-cost alternative to bipolar logic. This steady advance in MOS technology has increased the large scale integration of digital circuits from 100 MOS transistors per chip to over 14,000 per chip during the last five years. This increase in chip density has caused a revolution in digital hardware applications. Among the more publicized are the pocket calculator and the digital watch.

A microcomputer uses no more than 10 MOS/LSI packages, each holding more than 500 transistor circuits. A minicomputer would typically require about 100 TTL packages. This simple comparison reflects the prime difference between a minicomputer and a microcomputer – its physical size and the complexity of its components.

A concurrent development which has contributed to the evolution of microprocessors, and thus microcomputers, is microprogramming, where each machine instruction initiates a sequence of more elementary instructions (microinstructions). A microprogramming approach allows, replacing fixed, conventional, CPU control logic with a control memory. Addresses in control memory represent unique states in conventional control logic, and each memory output represents control lines from conventional logic. Stored in this memory are basic microinstructions, including the fundamental control, testing, branching and moving operations.

For an LSI machine to perform higher-level operations with ease, microinstruction sequences corresponding to common higher-level functions are stored in a separate read-only memory (ROM) to be accessed, decoded, and executed on command. These high-level sequences are called macroinstructions, the medium in which system programmers usually code. Macroinstructions in a microcomputer correspond to the basic instructions of a minicomputer.

Microprogramming enables a systems designer to adapt standard hardware to specific applications – perhaps the most useful characteristic of a microcomputer. The designer can construct macroinstructions that are best suited for the particular functions to be performed, and incorporate them into the microprocessor. For example, the instruction set of an existing minicomputer can be completely or partially emulated to minimize software development. Alternatively, a machine can be built to perform functions peculiar to an application such as word processing or data acquisition. This capability to adapt a standard set of hardware modules to a variety of problems combines the cost advantages of high-volume chip production with the computing efficiency of tailored instruction sets.

MICROCOMPUTER vs MINICOMPUTER

Although stark and simplistic price comparisons are sometimes misleading, it is not unfair to say that an LSI microprocessor has a substantial cost advantage over a typical minicomputer CPU. For example, a complete LSI CPU may be purchased for as little as $300, compared to $1000 to $2000 for a minicomputer CPU.

The CPU power consumption of an LSI microcomputer is 66 to 75 percent less than that of a comparable minicomputer. For a system containing but one CPU, the difference would not be significant considering the overall system's power requirements. However, in applications where many CPUs are required, the power difference would be substantial.

An MOS/LSI microcomputer operates at 50 to 33 percent of the speed of commercially available minicomputers. Typical memory-to-memory add times for a moderately priced mini are between 5 and 20 microsec compared to 15 to 60 microsec for a microcomputer. The speed of a microcomputer is derived from the particular MOS process used in fabrication. As these processes improve, so will the speed.

With integrated circuits, system reliability is largely a function of the number of printed circuit (PC) board interconnections. Since each LSI package replaces from 50 to 100 TTL packages, the interconnections required by microcomputers are reduced and total system reliability is increased. The LSI microcomputer can be built into a light and compact configuration because of the higher number of gates per package module and the simplicity of interconnection.

In summary, the LSI microcomputer offers better price-performance, lower power consumption and heat dissipation, higher reliability, and smaller physical size than a minicomputer. The microcomputer further offers the flexibility of microprogramming, which, in a given application, has many advantages. Although execution speeds comparable to today's minicomputer have not yet been achieved, several architectural techniques have emerged which will eventually increase microcomputer speeds.

CHARACTERISTICS

Microprocessor architecture is similar to that of a bus-oriented minicomputer. Applications can generally be categorized by bit width: four-bit microprocessors for calculators; eight-bit units for microcontrollers; and sixteen-bit units for microcomputers. The range of characteristics is broad:

Data Word Size
4 to 100 bits

Instruction Set
40 to 120

Instruction Format
8 to 24 bits

ROM
400 23-bit to 16K 8-bit

RAM
up to 65K 16-bit

General-Purpose Registers
1 to 16

Cycle Time to Fetch & Execute An Instruction
0.54 to 62 microsec, with
5 to 10 microsec common

Stack Depth
2 to 32 levels

Interrupt Capability
None to full

Parallelism
mostly parallel
to serial/parallel

An example of a microcomputer is Teledyne Systems' TDY-52, a programmable microcomputer contained within a 2" x 2" x 0.2" package. Teledyne offers two different configurations of the TDY-52: the TDY-52A, a package holding a CPU with 8 registers, a 4K x 8-bit microinstruction ROM control memory, 4K x 8-bit application program · RAM memory, a 2K bit scratchpad RAM, input multiplexer, output buffer registers, priority interrupts, and oscillator; and the TDY-52B, a general-purpose 16-bit microcomputer with CPU and registers, priority interrupt, memory and I/O address register, clock generator, timing and control, and output buffers. Both configurations can also incorporate additional ROM, RAM and ROM/RAM modules, contained within another TDY-52 size package.

CONFIGURATIONS

Manufacturers provide three forms of microprocessors: MOS/LSI chip sets; a single PC card with processor and memory; and a card cage system containing a CPU card, memory cards, direct memory access channel cards, bit interface cards, and connectors for attaching a portable control panel.

Chip sets are suitable for large quantity requirements. The OEM buyer must meet loading restrictions and supply the required clock waveforms indicated in the specifications for the MOS chip.

A PC card approach provides a low-cost CPU that can be incorporated into existing hardware, eliminating most of the problems of interfacing. It is an excellent method to get a new product underway quickly, and can give way to the chip set at a later time if quantities are sufficient.

A card cage system is suitable primarily for breadboarding and prototyping. It comes complete wih power bussing and a breadboarding card on which the user may construct his own interface logic.

APPLICATIONS

The potential applications of microprocessors and microcomputers extend over a broad spectrum of products. Their principal use to date has been in electronic calculators – the extremely high volume quantities required by this market segment dictating the architecture of many microcomputers.

Terminals will be the next major market area to utilize microcomputers. Low-cost data terminals use microprocessors for simple data handling tasks. Remote terminals, by the addition of a microprocessor, become "intelligent," and perform off-line editing, compiling and processing. Point-of-sale (POS) terminals perform calculations, data storage and inventory control functions, and control keyboard, tag reader, display and printer peripherals under microcomputer control.

Microprocessors are useful for tasks normally associated with large-scale systems. In addition to performing channel control functions, they relieve the large central processor of the overhead associated with scheduling, text editing or file management. In a similar manner, microprocessors can be used for sequencing, control, formatting and error detection in tape or disc units. It is probable that more microprocessors will be buried in computer peripherals than will be used as computing devices.

LSI microprocessors, combined with low-cost memory and moderate performance peripherals like floppy discs, CRT displays or medium-speed printers, can provide all the processing power needed for many applications. A large multi-user computer system may soon be needed only for accessing large, on-line data bases or for a few CPU-bound program tasks.

In summary, microprocessors and microcomputers are or soon will be applied to the following types of equipment:

Calculators, both programmable and fixed-function, and small business/accounting computers

Terminals, both keyboard and special-purpose

Measurement systems, from panel meters to full-scale monitoring systems

Automotive systems and traffic controls

Medical equipment

Process and machine control

Computer peripherals and system control.

CONCLUSION

LSI microprocessors and microcomputers will soon replace conventional minicomputers and controllers in many applications where a mini or controller is overpriced or overpowered. Microprocessors now satisfy those minicomputer applications where high speeds are not required. Speeds of minicomputers have increased over the years mainly as an enhancement due to changing technology rather than in response to an overall need. While TTL logic was the least expensive technology, very little cost reduction could be realized by producing slower minis. The advent of the LSI microprocessor thus is forcing a reexamination of minicomputer price-performance tradeoffs.■

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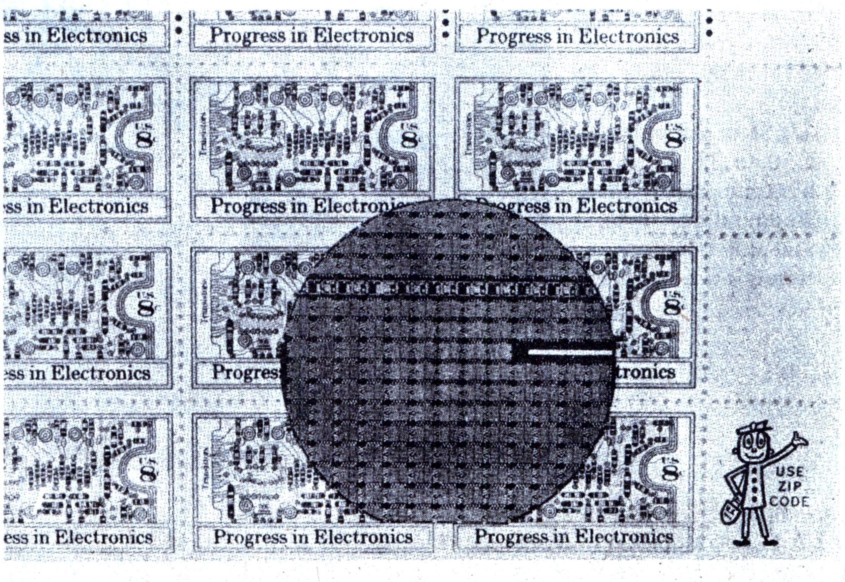
HOW SMALL IS SMALL?

Microns and nanoseconds are units too small to conceptualize directly. But the accompanying photograph illustrates graphically, and dramatically, how far we've come in designing microminiaturized computer components. Shown superimposed on a background of postage stamps is a 2-inch wafer containing 130 integrated circuit chips. Each chip contains 4,200 transistors, for a total of 546,000 transistors on the wafer. The stamp is one of four "Progress in Electronics" commemoratives issued by the U.S. Postal Service in July. The chips are manufactured by Western Electric for use in telephone switching systems.



PERSONAL COMPUTERS

Personal computers may now prove to be less expensive and more efficient than time-sharing.

Once upon a time, when computer technology first evolved, users had intimate contact with their machines on a one to one basis. Turnaround was fast, response predictable, and debugging immediate. But unfortunately there was too little computing power to go around, and what was available was too costly for many to afford. When a resource is scarce, it makes sense to share it, even in the face of extra administrative cost. Thus, the concept of time-sharing was introduced.

Time sharing is an idea which has dominated interactive computing for more than a decade. But because of system complexity and integrity considerations, most time-sharing systems offer only very limited access to the capabilities inherent in the machines on which they operate. A time-sharing system's performance deteriorates rapidly with the number of users, and the overhead due to frequent and careful task switching and memory management makes time-shared computing relatively expensive. As the number of users increases, so too does the amount of time the machine spends debugging rather than executing complicated programs.

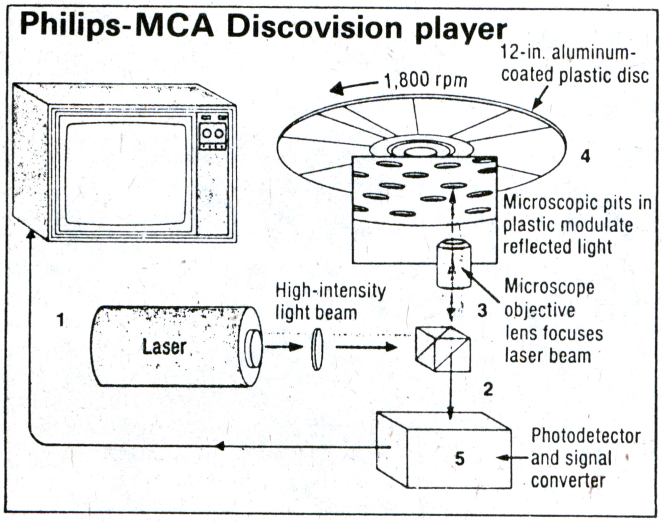
Overall, the step-wise growth in system complexity made sense while hardware was expensive and software could be cheaply extracted from enthusiastic young people willing to learn. But today software costs are up and hardware costs are plummeting downward. The new computer economy seems to have come full circle. Personal computers may now prove to be less expensive and more efficient than time-sharing.

A personal computer is a non-shared system containing sufficient processing power and storage capabilities to satisfy the needs of an individual user. The most advanced of the new personal systems include mass-produced memory and processing modules which can be adapted to a user's specialized needs. Several modules may also be joined and modified to reflect user need, and a group of personal computer modules might even be used somewhat like a secretarial pool, in which each is totally dedicated to a user's need at one particular time, while it resides in a central pool otherwise.

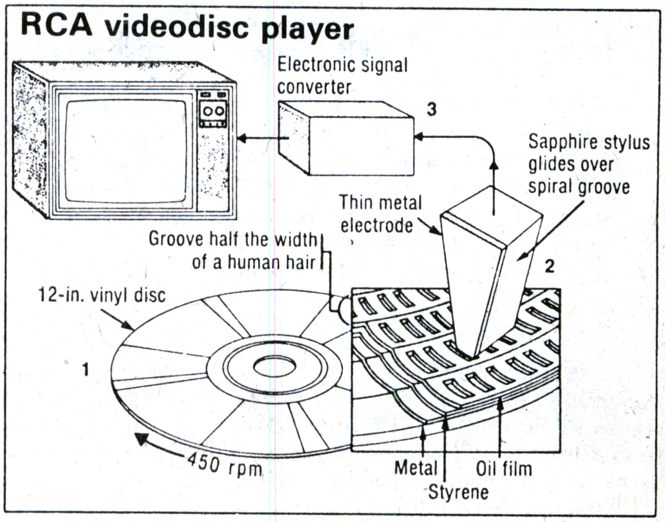
Personal computers, such as the ones being developed now to handle very large programs or to provide educationally-oriented systems, are quite expensive, but after the heavy initial investment in design, turning them out should become much like cutting cookies out of dough. Just as time-sharing originated out of economic necessity, personal computers which can be easily adopted to individual user needs begin to make sense today. It is certainly superior to have 30 systems that give excellent service for 33 thousand dollars each than to have one time-sharing system that cannot adequately support thirty users (doing serious, sophisticated computing) and costs one million dollars. Or for that matter, for specialized tasks how about 200 microprocessor-based systems for $500 each instead of an overloaded 32-user minicomputer time-sharing system costing $100,000? With the new systems, software costs are greatly reduced, and speed and efficiency will prove cheaper and more reliable. Conceivably, as hardware costs continue to decrease, these machines may eventually be distributed like pocket calculators or pencils.

[Adapted from "Personal Computers" by B. Horn and P. Winston, *Datamation*, May 1975.]

HOW THE VIDEODISC PLAYERS WORK


Philips-MCA Discovision player
12-in. aluminum-coated plastic disc
1,800 rpm
4
Microscopic pits in plastic modulate reflected light
High-intensity light beam
1
Laser
3
Microscope objective lens focuses laser beam
2
5
Photodetector and signal converter

OPTICAL PICKUP: A laser (1) generates a light beam aimed by a prism (2) and focused by a lens (3) on a disc (4) coded for picture and sound. Reflected light strikes a photodetector (5) that converts it to signals that are processed and fed to a TV set.


RCA videodisc player
Electronic signal converter
3
Sapphire stylus glides over spiral groove
Thin metal electrode
Groove half the width of a human hair
12-in. vinyl disc
2
1
450 rpm
Metal
Oil film
Styrene

ELECTRICAL PICKUP: The picture and sound code on a spinning disc (1) is picked up electrically by a stylus (2) that transfers signals to a converter (3). The converter processes the signals into electronic form accepted by a TV set.

Round and Round They Go

Even a child could operate the video-disc players to be marketed next year, say the manufacturers. The players, which feed television signals from 60-minute phonograph record-like discs into television sets, could allow unprecedented freedom in home television viewing (photo courtesy Philips-MCA).

One pitched battle in the consumer electronics industry over the next few years will be between RCA Corporation and a partnership of MCA, Inc., an entertainment conglomerate, and N. V. Philips, a Dutch electronics corporation.

These two competitors plan to market systems late next year for playing phonograph-record-like video-discs on a $500 player attached to the home television set. The possibilities for such a system are enormous. Not only could viewers select any program they wished, no matter how esoteric (or erotic), but home study would boom. Do-it-your-selfers could actually *see* how the whatzit attaches to the whozit; medical students could play and replay their favorite operations; massive amounts of information could be cheaply stored on the high-capacity discs for use in the home, government, industry, or academe.

The catch is that RCA and MCA-Philips have come up with two different and incompatible methods for home TV records. RCA relies on a sensitive needle tracking a tiny spiral groove as the record spins on a 450 r.p.m. turntable. The video picture and sound signals arise from the changes in electrical properties as the stylus speeds through the grooves.

Philips and MCA combined their formerly rival technologies to develop a system based on a laser beam in the home player. As the disc spins at 1800 r.p.m., the finely-focused blue beam bounces off a succession of tiny pits arranged in a spiral on the record's surface; the resulting reflections constitute the signal for the television. In producing a disc that could store about 30 minutes of television per side, both RCA and MCA-Philips have developed systems capable of storing tens of billions of information bits, and both can give stereo sound along with a high-quality color picture.

The systems represent remarkable achievements, and certainly promise to out-perform the once highly touted videotape players, which have settled at prices too high for the average consumer — $1000 for a player and $30 per 30 minutes of taped program.

The two companies are making subtle and not-so-subtle jabs at one another even before entering the marketing ring. For instance, RCA claims that its system will be reliable and cheap because it is fabricated from conventional components that have been on the market for many years. The sturdy stylus can be replaced as easily as a phonograph needle. No complex beam-aiming mechanism is needed for the needle-in-groove system. And the lower rotational speed significantly reduces the possibility of vibration in the system, say company spokespersons.

Philips-MCA counters with the assertion that all its components have been mass-marketed for years: advanced optics systems in cameras; integrated circuits in computers, lasers in office, military, and space equipment; and high-speed discs in computer storage units. Optical equipment allows higher storage capacity, say company engineers. Philips-MCA has achieved a storage density that could permit up to 60 minutes playing time per side. Because nothing touches the disc and the "pits" are protected by a layer of plastic, the record will last indefinitely. On the other hand, RCA video-discs lasted through about 500 plays, as does the RCA stylus; RCA says that's as many times as anybody would want to play anything anyway.

Philips-MCA has another ace up its sleeve: although both systems can scan the record to replay a desired segment, only the Philips-MCA laser system can freeze the picture — by scanning the same groove again and again. This means that, with the high information capacity of discs, huge amounts of printed information could be put on a single video-disc, with one page per picture frame. The user could search out a page merely by punching in its address on advanced machines to be developed later.

According to the company, the entire Encyclopedia Britannica and all its supplements could easily be stored on a single disc. Philips-MCA systems with computers attached could also be used as teaching machines. The student would proceed through a teaching program, and as his progress warranted, the computer would call up one or another video instruction sequence on the player.

As an interesting aside, Philips-MCA plans to produce laser-read audio records to be played on its system. The scratch-proof disc would allow up to 15 hours of noise-free stereo per side. Remarkably, the disc capacity is so great that each instrument in a 100-instrument orchestra could be recorded on its own separate channel.

MCA also has access to the enormous film library of its subsidiary Universal Pictures, and plans to produce new programming for video-discs once the system is on the market. Whether or not the film library, containing over 11,000 titles, will be an advantage is questionable. Will people pay up to $10 to see movies and television repeats readily available on commercial television? Certainly "Francis the Talking Mule," one MCA offering, will not find a large following.

Whichever system is triumphant, "narrowcasting" — as Philips-MCA calls it — will enable an unprecedented freedom of choice in television viewing. — *D.M.*

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Videodiscs — The Ultimate Computer Input Device?

by Alfred M. Bork
University of California, Irvine

I'd like to discuss with the readers of *Creative Computing* the extremely exciting possibility concerning the marriage of video disc and computer technology, particularly microcomputer and graphic technology, with emphasis on educational applications.

First, it will be necessary to describe the videodisc system, as it is unknown to the general population as well as to people in the computer world. The development has been going on during the past five years or so by a number of major manufacturers around the world. The basic idea is to provide an inexpensive way of showing video through everyone's home TV. The developers hope to sell the unit to many of the people around the world who have television systems, and plan to sell "records," containing films and other things, to be played through home television sets. It should be noted that this is an extremely large market, so all the economies of scale available through large numbers would be present.

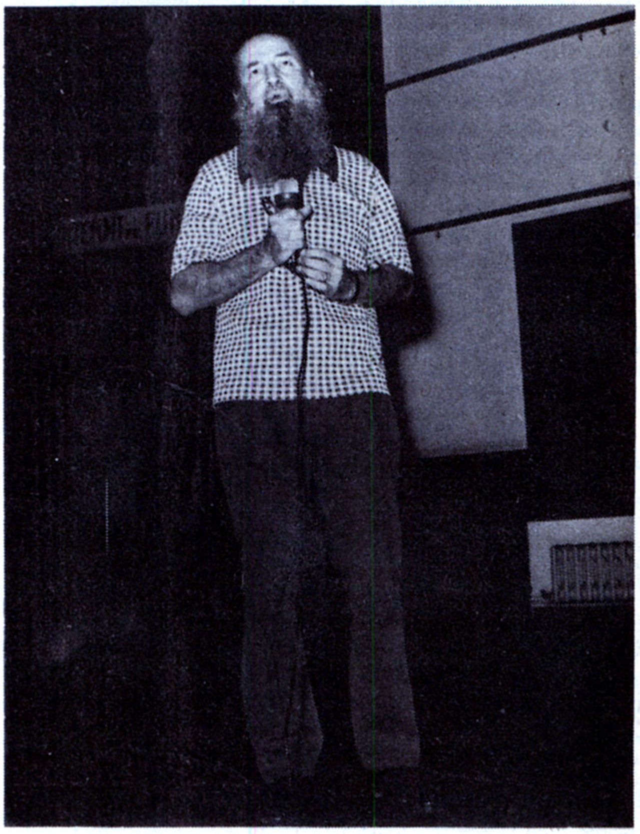
The leading system presently is that developed by Phillips-MCA, although other companies are active in developing similar systems. They have often been demonstrated publicly for several years, and the systems do work. The recording is *not* magnetic—one of the reasons for this development is that magnetic tape recorders for home video have proved too expensive and too subject to problems. The recording media is more like that used in ordinary records, with a number of candidates being used. One possibility is simply pressed vinyl, exactly the same technology used with ordinary records, but with much closer grooves. In many of the systems the grooves are read by laser beams of light modulated by the shape of the groove, rather than mechanically. Typically the discs are rotating at 1800 RPM, so that one track around has the information for one TV picture. Times of approximately one hour of video per disc side are suggested by the developers.

At first glance the videodisc system, while exciting in its own right, does not appear to have any direct connection with computers, and particularly with educational uses of computers. The developers of videodisc systems are not fully familiar with the possibilities of very wide-scale computer-assisted learning systems.

I've long been convinced that the ultimate and inevitable outcome of microcomputer technology, evolving often extremely rapidly, will be that we will eventually find all the processing capability for computer-based learning systems directly in the device itself. While such a system might occasionally connect to a remote computer, for access to large-scale databases, or rapidly changing databases, or for access to massive computational capabilities, these systems would mostly function alone.

This type of system has tremendous advantages. First, a breakdown affects only that particular system; second, no communication costs are involved; and third, none of the present limitations of communications speeds over ordinary phone lines (usually for economic reasons) are present. Fourth, these systems allow highly interactive graphics, because they do allow very rapid speeds, TV bandwidth, impossible today from a practical point of view for remote displays. I believe that graphics is an important component of all educational systems, and it seems to me that the stand-alone system, with its own built-in processing capability is the natural solution with present technology.

The stand-alone system very much needs the videodisc for a variety of reasons. The videodisc used in the stand-alone system, however, would be somewhat different from the one for the home TV system, particularly in terms of the type of information stored on the disc. One of the most interesting aspects of the disc is its very large capacity. An



IFIP World Computers in Education Conference attendees hear about graphics and videodiscs from Alfred Bork.

hour's worth of TV corresponds to about 10^{11} bits of information. Discs are already randomly accessible although at too slow a rate. It does not seem to be too great an engineering problem to increase the ability to access randomly an area of the disc given that all that is necessary is to move a light beam.

I envision that each disc will contain a complete multi-media teaching package. Thus, a particular disc might be an elaborate teaching sequence for physics, having on the disc the computer code for that sequence (including possible microcode to make the stand-alone system emulate the particular machine that material was originally developed for), slides, (one turn around the disc), audio messages, and video sequences of arbitrary length, all of these many different segments. Thus, a teaching dialog stored on a videodisc would have full capability of handling very complex computer logic, and making sizable calculations, but it also could, at an appropriate point, show video sequences of arbitrary length or slides, or present audio messages. Another videodisc might have on it a complete language, such as APL, including a full multi-media course for leaning APL interactively. Another might have relatively little logic, but very large numbers of slides in connection with an art history or anatomy course. For the first time control of all the important audiovisual media would be with the student. The inflexibility of current film and video systems could be overcome too, because some videodiscs might have on them simply nothing but a series of film clips, with the logic for students to pick which ones they wanted to see at a particular time.

The procedure I envision would be something like this. The videodiscs would be prepared by some central sources, either the large educational technology centers discussed in the Carnegie Commission on Higher Education study, *The Fourth Revolution*, or by commercial vendors, perhaps even the current textbook publishers. They would be stamped out by record companies, and they would be sold in stores as ordinary records are. Note that the manufacturing technology for such records is expensive, so there is likely to be little pirating. It is much easier to copy a magnetic tape than it is to produce a new record without access to the master.

Thus, we would have, for the first time in using the computer in instructional ways, a sellable product, difficult to pirate. This would mean that all the usual mechanism of royalties for authors, advertising the materials, etc., would be possible. Students would carry home a stack of records, representing courses they were going to take. The record would be put into a slot in the machine, perhaps using the student's own home TV set and home videodisc unit (although it's not clear that this last would be possible without some modification). The lesson would start up immediately as soon as the start button is pressed.

Although I refer to the device as being in the student's home, it might well be in an educational institution, either a conventional one such as a school or university, or an unconventional one such as a public library. Indeed, one would expect that the records would be available for loan in libraries just as current records are available in many libraries. If record keeping were necessary to insure credit or for taking on-line exams, this could be done either by dialing to a remote computer or by local magnetic storage, perhaps a spearate floppy disc, perhaps a magnetic area on the videodisc.

We should not underestimate the needs of computational capabilities here. It may be that through use of the fixed storage media, the videodisc, we will be able to get by with less "real" storage, and some fast memory will be essential. Some storage will be necessary to refresh a TV screen rapidly; the screen resolution will be very important so that storage will not be trivial.

How do we get all this to happen, and what kind of time scale are we talking about? The time scale seems to be on the order of five years, perhaps a bit longer. The microcomputer technology has perhaps not evolved quite to the point that would make this system economically practical, but it is rapidly approaching such a situation.

The videodiscs are not on the market, and it is possible that there may be competing systems before the issue is clarified. One of the most difficult issues is to bring together people with educational computer expertise and people with expertise in the videodisc technology. Perhaps the first demonstration systems will be developed in university laboratories, or in collaborations between universities and industrial companies, before companies are convinced of the vast possible mass markets for such systems.

So far computers, although useful, are not playing a major role in our educational system. The vast majority of students, both at the K through 12 level and at the university level, never see computers except possibly in courses exclusively oriented toward teaching programming. So the full potentiality of the computer for revolutionizing the way students go about learning is not yet fully appreciated. Nevertheless, this effectiveness is real, and views of the future of learning which do not include extremely heavy use of the computer are inadequate. While one can develop various views of the future (the one in George Leonard's book, *Education and Ecstasy*, is an appealing possibility, somewhat different from the one suggested here), the prospects are nevertheless exciting. Let's get to work on it!

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The $2.98 Computer Library

by Arthur Luehrmann
Director, Project COMPUTe

A BASIC interpreter plus all the programs in the Dartmouth library, ready to run on your home computer, for $2.98? Space-war, in full color with sound effects and electronic music, right in your living room? A complete, conversational, interactive program to teach you French in 100 lessons—all for $5.00 and ready for your computer?

Does this sound absurdly futuristic? Well, it may not be as far off as it appears. First, let's think about the idea of a home computer. Most people already own about a fourth of one. One's color TV set is a rather good display device and every computer needs one of those.

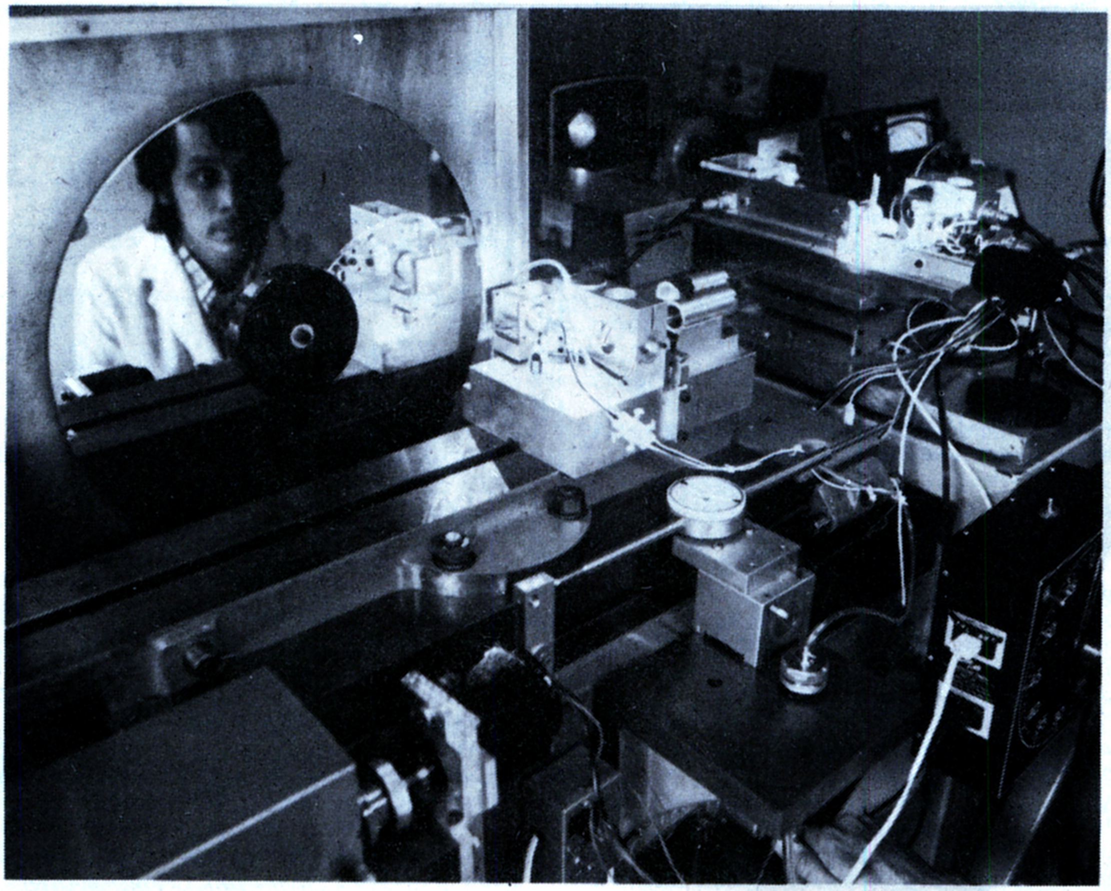
Many people will soon be buying another fourth of their home computer in the form of a videodisc player. Of course, they won't be thinking of it as a piece of a computer, but a videodisc really is a random-access read-only memory with a capacity of about 10^{10} bits. In addition to pictures and sound it can contain computer instructions and data. And it will cost only a few dollars per disc.

Well, that's half the job. The missing part is the processor, memory and keyboard, of course; and it's hard to see why people would want to spend much money for these items. But is it so hard after all? They buy TV sets for their entertainment. They will buy videodisc players for the same reasons. Perhaps entertainment will, in part, motivate buying the rest of the family computer. Everyone knows that computers play pretty good games. People are already paying $100 or more for electronic games like Pong and Odyssey that can only do one or two things. A general purpose game player has all the attributes of a general purpose computer.

The attractiveness of games, augmented by utility computational programs and educational programs will stimulate the spread of the home computer. And the spread of the private computer will create the demand for new software—new games, new utilities, and new courseware. In the course of time widespread demand will provide the economic incentive for authors of software and courseware to write new or improved programs.

The videodisc process may be as important to the publishing and distribution of non-verbal information as movable-type printing was to the written word. In both cases mechanical stamping replaces tracing, whether by monks or magnetic tape recorders.

So don't be surprised in a few years, friends, to find advertisements in the newspaper for Software Specials at your local supermarket. I can see it now: "A Golden Oldie—FORTRAN—a Closeout Bargain at $1.49—sorry, no refunds!!!"



Cutting a videodisc master with a laser. In quantity, discs can be produced for 40 cents although after programming, packaging, royalties, marketing, and distribution, the selling price will be closer to $10. (Photo courtesy Philips-MCA.)

INFORMATION ANYONE?

INFORMATION
GBeker © '75

Illustration by George Beker

by Bill Griffith
Boston College

You are nobody unless you have your share of information. Money is not power, knowledge is not power — information is power.

With the CIA collecting information on private citizens (Why don't they stick to overthrowing foreign governments?), commercial credit companies recording the contents of your trashcans and your seven year old using words like "software" and "hardware" and "PL/I", is it any wonder you wonder? "It all looks too big and complicated.", you say. "What can I do about it anyway, I'm not an expert?" Well, it can get pretty scary if you think about the ramifications of all this in our computer-infested society. It's all very serious. But it seems to be serious in a way that caused people to do nothing about it. They can't even laugh about it. Now scary is O.K. if you use the fear towards productive defense and laughter is O.K. if it puts things into a workable perspective.

I work in a computing center and some times it gets pretty hectic. One night, after a particularly grueling day, I passed out at about 7 P.M. and I dreamt that I couldn't speak unless I talked in JCL. Now, JCL, for those of you who have the fortune not to know, is short for Job Control Language, which is kind of a pseudo-language used to get your work through IBM's larger computers. We've all had nightmares — tigers chasing you, falling down endless holes — the usual nightly ramblings of our collective unconscious. This one however, freaked me out a little more than the time I was about to be crushed to death for playing with a OUIJA board at the blessing of the fleet in Gloucester. No one could understand me except systems programmers and the computers themselves. I couldn't order dinner, I was banned from the singles bars (my wife was happy about that — serves me right), and I was bitten by our pet gerbil. Fortunately, I woke up before I starved to death or whatever. The ramifications of this nocturnal psychic spasm began to revolve in my head and I was led to an appendix in *1984* which discussed the language of the future, NEWSPEAK.

> *The purpose of NEWSPEAK was not only to provide a medium of expression for the world view and mental habits proper to the devotees of Ingsoc, but to make all other modes of thought impossible.*

It takes a very special turn of mind to be able to communicate with a computer. You have to use a language which is unambiguous and any "sentence" you construct will, at least in the context, be univalent—i.e.—it means one thing and only one thing. Now I admit it can be a real kick (and useful) for linguistic puzzle maniacs both to construct and to try and break such languages. However, if you continue to think in these strictured terms, it is rather unlikely that you will say anything that will ultimately benefit humankind. After a hard day at the coding pad (the blocked and lined paper programmers use to record their musings), I once went to a cocktail party in Cambridge and I was unable to enter into the current discussion about the 19th century symbolists because I couldn't say anything relevant in FORTRAN. That was the day I chose to go into management. I figured that this might save me from the shrink or at least if I went to the shrink I could still talk to him/her. At the time I didn't realize that programmers don't need shrinks anyway and that managers do because they can still think about what's bothering them enough to have it bother them.

I often ask myself what in the name of heaven ("heaven" is a legitimate variable name in most computer languages) we are doing with these monolithic monsters. Pretty soon we won't even be able to use words like "freedom," "liberation," etc., because they won't mean anything anyway. You've got to have a counter-vocabulary to produce creative change; but the language is fast reducing, at least in the career circles I run in. In contrast, the social environment (at least, mine) doesn't seem able to respond at all. And these people, I like to think, are intelligent, caring individuals but when they ask me what I do I find myself speechless or mumbling. When you think about the so-called lack of religion in our "post-modern" world, you quickly find substitutes abounding in the techno-scientific fields. You can tell where pseudo-religion is because that is where mystery is. Any religion worth its salt leads to knowledge, not mystery. So the new mystery-religion is upon us in the form of technology and the new high priests are the systems analysts and programmers. Every cult has its symbols and computerese is no exception. It's impossible to fight, if you stand in awe and wonder. I find awe and wonder best reserved for sunsets and rainbows and only a way of avoiding responsibility when it comes to technology. As in Newspeak, some programmers sit up nights trying to say more, more efficiently and with less "words" and giving themselves gold stars when they succeed in doing it. I admit to all the "wonder"ful things computers have done — they have eased out bureaucratic pains, made our lives more efficient and carefree, simplified government and helped catch income tax cheaters and who am I to argue with "rationality." Anyone who stands in opposition to "technique" certainly has a suspect mental balance. Who can stay the tide of technological sophistication? Now that's a word — sophistication. It means neat, cool and in the know — sexy even (we'll get to that in a later article for you neo-Freudians out there.) But one of the meanings which we overlook is *complex*. Whenever a computer salesman uses the word sophisticated, I get hives. And do we remember the sophists? They didn't say anything but how wonderful it sounded and who would volunteer ignorance of what they were talking about? Somehow, I don't fear any organized takeover of the language a la *1984* but I sure as hell worry about habitual lack of responsibility — we don't need to be taken by force, why waste the effort — we'll take care of ourselves ourselves. So, next time somebody says a word you don't get — ask them to explain it until you understand. You didn't get into a responsible position by not asking "stupid" questions, so why stop now? Get out that copy of Webster's and cherish it — hug it to your breast. It may be more important than the Bible in the decade to come. Have you seen *Fahrenheit 451?*

One night, after a particularly grueling day, I passed out at about 7 P.M. and I dreamt that I couldn't speak unless I talked in JCL.

There is another side to this technological revolution and that is information. Even the computer is falling into the background of information. It is no longer computer processing or data processing but information processing. Everybody has to have information—managers need information, congress needs information, hospitals need information. You are nobody unless you have your share of information. Money is not power, knowledge is not power—information is power. Some people don't seem to want to know anything, but they sure as shootin' want to know about everything. And if you give them a T.V. computer terminal they will certainly use it even if they don't need it. Now in order to fulfill this addiction to information, we need information. I remember someone quoting J. Edgar as saying "We have dossiers on 95% of the American public and we must close this gap." Why do people collect information—the IRS, the CIA, the FBI, commercial credit companies? Only to have it—I know they give other reasons but "only to have it" is the truth. They have to supply the habits of the "information seekers." If you are a manager and you have no MIS (Management Information System) where is your credibility? What do you want to know—it may not matter, you'll figure out something . . . later. Right now, collect that information. Meanwhile . . . all the information has been collected. It reminds me of a thought Marshall McLuhan put forth in *Understanding Media*—you invent T.V. and what a marvel it is; what a wonderful communications media. Then you put the control of the media into the hands of the networks and they don't worry so much about all the wonderful things we could communicate but how to fill up the time slots. Now this wouldn't be so bad if people didn't have the mistaken idea that all we are is what somebody knows about us. I don't like to see tighter social control via data banks but I feel that if we are only our social selves (what is known about us) then we are in big trouble. In fact, believing it is the best way to reinforce it. It breeds fear, lack of self-expression, secrecy and in the age of communication we find ourselves communicating less and less. I would like to shout from the housetops, "INFORMATION IS NOT TRUTH." You see, when we moved from data to information a very subtle transition took place. Data is not just data but reality (where did I hear that?) when it is information. It is now in-FORMED—it has form. Somehow, we are lead to believe that the evaluation has already taken place when the information arrives on our desk. IT HAS NOT. What about the content? Who cares? We should. Someone once told me (or did I think it up all by myself?) that management information is anything that a manager reads that was printed by a computer. Oh well! The problem is that information has a rather unbiased tone about it when at the same time it is heavily biased. Oh for the days of the Buddha when "all you were was the result of what you had thought" rather than today when all you are is what somebody knows about you. So in between your Peter Drucker and your IBM manuals (they are second in publication only to the U.S. government—that's one for the time capsule) see if you can't sandwich a copy of some O. Henry or some Mark Twain or the Bhagavad Gita. It'll do ya good.

In closing, I would say that I am not a cynic—far from it, but one who wants to take the responsibility for my small area of the universe as all should. I do it badly sometimes and sometimes well—but I do. The computer has no intrinsic moral bias but when it imbeds itself in a culture as it has today—it does. "Back to nature" won't help. You'd better have a book on systems in one hand and a philosophy book in the other or it is all over. The only way around it is through it.

GRAND OPENING

by Emily Pritchard Cary

One of the grandest of the Grand Openings was abruptly halted on Friday, April 11, 1975, at approximately 4:30 P.M., when an uncooperative component in a freshly installed Bunker Ramo Electronic Store Information System ceased operation.

The resulting pandemonium cast Mike Madonna, manager of the spanking new Shop-Rite Super Market in Springfield, New Jersey, into an unenvied starring role heretofore played only in recurring nightmares.

This nightmare, peculiar to supermarket managers, is heralded by a vision of the store crammed with customers, their shopping carts filled to overflowing in anticipation of the upcoming weekend. The clerks at the check-out counters are handling the throngs with customary efficiency. Suddenly, an inexplicable malfunction in the computer-based registers halts all operations.

Within minutes, chaos prevails. Irate shoppers, each intent on immediate attention, become restless, then belligerent, ultimately storming the aisles. The nightmare soars to a climax so hideous that the store manager wakens—screaming—in cold terror, fancying himself merely inches from the wrath of a lynch mob.

What happened when that nightmare slipped across the gossamer barrier which transformed it into reality?

Let me begin where I began, armed with an empty cart, a wallet wadded with crisp bills, a lucrative assortment of clipped coupons redeemable only during the Grand Opening Weekend, and a heart happy in the knowledge that both employees and mechanical complexities therein would mold my turn around the store into a memorable event.

"It's bad enough being trapped in a Grand Opening mob, but it's an absolute crime to be kept prisoner by a broken-down machine."

It was!

Police officers were on hand to direct cars feeding from the highway into the parking lot which already was jampacked. Inside, a bevy of official caps bobbed among the milling bodies, helping to steer foot and cart traffic through the aisles.

I decided to work systematically, beginning my forage on the far side in fresh produce. Despite the crowds and the difficulty in propelling my shopping cart with any semblance of speed, I did not feel inhibited. Clerks in the delicatessen, seafood, and fresh meats departments hustled through their chores, servicing each customer with dispatch. When one customer preceding me down the aisle was momentarily stymied by a blockade of carts ahead, she mused, "The crush is dreadful today, but it shouldn't be so bad in a few weeks when things settle down."

Her companion observed the energy of the check-out clerks responding to the rush of business. "Don't worry," she consoled. "Once we reach the counter, they'll whisk us right through!"

Admittedly, the entire process absorbed double the usual time, but much of the delay could be attributed to unfamiliarity with the shelf arrangements, the small children underfoot who were actively in pursuit of balloon-distributing clowns, and the gaggle of company representatives proferring product samples at several key intersections.

I rounded the final aisle wealthier by a number of freebees, secure in the knowledge that the endeavor had been rewarding.

A cursory glance at the ten check-out counters revealed some delay. I would have to wait my turn behind at least six other shoppers with carts piled high. I opted, therefore, for the nearest slot. As I edged my groaning cart into place, the woman ahead spun around and glared, fury peppering her countenance. What had I done wrong?

Studying customers in other lines, I realized that all wore venomous expressions. No longer were the clerks at the check-out stations herding the orders along with the alacrity and spirit exhibited earlier. Instead, all ten of them—together with their accompanying baggers—stood doggedly still, arms folded. A pervading silence further verified that something was amiss.

Whispers trickled back from the front of the store. As they spread to a steady murmur, I detected a lethal word flitting from one counter to another: "Strike!"

The word bounced back and forth several times, swelling to a roar like a cyclone building momentum. An elderly woman nudged me, ominously, "They've gone on strike!"

I did not know if she spoke the truth, but the mass inactivity up ahead deemed it a likely possibility.

A man behind me overheard her. "Good God!" he shouted. "Let's get out of here. There's liable to be violence."

So saying, he grabbed his wife by the elbow and steered her to the door. "But . . . but . . . what about our groceries?" she protested. "Our cart is full."

"Forget it," he growled. "There'll be plenty of trouble here in a little while. We don't want to get involved."

Once outside, he confronted potential customers, alerting them to the situation. The recipients of his bad tidings froze in their tracks, stared—disbelieving—through the huge plate glass windows at the motionless mob, then wheeled about and returned to their cars.

A lady paralleling me in line took an alternative stand. "I've been through strikes before, and I learned that you have to hold your ground. It must be something about working conditions. The clerks don't look very happy, but they're bound to clear it up in a few minutes. The manager can't afford to lose all these customers. It took me two hours to load up my basket, and I'm not about to leave and start all over somewhere else. You'll see. They'll get this strike over within fifteen minutes, or I don't know what I'm talking about."

"Since you don't plan to leave," I said, "I wonder if you would save my place while I try to find out what the real story is."

"Sure 'nuff," she agreed. "We're not going any place very fast. I'll be here when you get back."

Within minutes, chaos prevails. Irate shoppers, each intent on immediate attention, become restless, then belligerent, ultimately storming the aisles.

Already the strike theory had spread, and one could sense the fear and frustration enveloping the customers. The choice was heady. Was it better to wait for an incalculable stretch of time, or to leave and forfeit the goods that had been a challenge to amass?

I inched toward the main entrance. A policeman there appeared to be the only person communicating verbally with the public. "Is it true the clerks have gone on strike?" I asked him.

"Wow!" He threw back his head and roared. "Did you hear that one? They think you're on strike," he told the nearest clerk.

"Who started that rumor?" the clerk asked, stupified.

"Some of the customers," I replied. "If you're not on strike, then what *is* the matter? Why aren't the check-out lines moving?"

"The computer broke down. Damn thing just up and quit. Can't do a thing with the registers until someone comes to fix it."

This struck me as being a severer problem than a strike. At least a hike in salary could mollify an unhappy employee, but what can be done about a cantankerous computer if there is no knowledgeable repairman on tap?

"How long will it be before someone gets here, and where are they coming from?" I asked.

"Who knows?" another employee shrugged. "Just hang in there."

Hang in? And for how long? I decided to query the service desk.

Three girls huddled together behind it in vague fear. They knew little about what had happened and nothing about what could be done to remedy matters. "Oh dear, oh dear. What can we do?" one muttered. "Look at the mob in the aisles!"

Addressing another girl, I asked, "Is your manager in the store at the moment?"

"Is he in the store? He'd better be, that's all I can say, or we'll all go crazy!"

The third girl, slightly more composed, suggested that he would be on the upper level where the computer held forth. "But you're not allowed up there," she remarked, defensively.

I sensed that she suspected I might try to storm the computer—or attack the manager—or perpetrate a violent act of the sort befitting a berserk customer.

"I have no intention of going up after him," I assured her. "I'm just pleased to learn the source of the difficulty. I'll go back now to report to the customers. They are becoming angry."

There was no denying their churlish deportment. Sporadic chants demanding immediate service swelled to a steady throb.

It was push and shove back to my shopping cart. All along the way, I cried out to as many customers as would heed my words that the strike rumor had been erroneous. "There is no strike," I repeated, over and over. "There is no strike. It's just the computer."

My words mollified some of the more belligerent customers who consented, reluctantly, to grant me passing room.

Upon locating my cart, I discovered that my message had advanced faster than I had. "Don't worry," the woman saving my place assured me, "they say it's just a computer. There is no strike."

"*Just* the computer!" a nearby man hollered. "Who're you kidding? That's an impossible mess! You don't get computers repaired for days, sometimes weeks. Probably the company is headquartered some crazy place—like Texas! That would be just our luck!"

That tore it! The rumor erupted, inviting anger to billow forth as word ricocheted around the store that the computer had blown up and would have to be replaced. A new one being shipped from Texas would not arrive for at least a week.

The mob surged forward. Or was it merely pressure amassed from shoppers queuing up behind us?

By now, all of the aisles facing the check-out counters were packed solid to the rear of the store with customers, their shopping carts laden with food. Surely thousands of dollars were at stake. Each person demanded immediate attention, computer or no. Hadn't the flyers received in the mail, the newspaper ads, and the gala banners strewn across the facade of the building promised super service?

These people let it be known they had not driven all the way from Elizabeth, Glen Rock, Ho-Ho-Kus, and Heaven-Knows-Where to be done in by a microscopic computer component.

"So get a cash register!" someone yelled.

"Cash register? Phooey! Get a hand calculator!" another suggested, in an unkind manner.

"Whatsa matter?" a more practical man boomed. "Ain't youse never heard of addin' wit' paper?"

"Good God!" he shouted. "Let's get out of here. There's liable to be violence."

A small child up ahead screamed with fury as the mob drove him into a magazine rack. "Gun shots!" someone gasped.

A sharp, metallic edge had popped the child's huge balloon bearing a slogan suggesting strict allegiance to Shop-Rite Super Markets.

In retaliation for his loss, the boy kicked his mother, who responded in kind by slapping him smartly and yelling for all nearby to hear, "Shut up, you fool kid! It's those jerks behind me who ain't got no manners! Quit your shovin'!"

The child screamed bitterly, but his cries were drowned by the drone of dissatisfied customers. Many among us were becoming edgy toward our adjacent fellow man with whom we were presently congregated for no reason other than we had elected to patronize the Grand Opening on this fateful Friday afternoon.

The rumor erupted, inviting anger to billow forth as word ricocheted around the store that the computer had blown up and would have to be replaced. A new one being shipped from Texas would not arrive for at least a week.

Suddenly, the loud speaker commanded our attention. "All Shop-Rite specialists to the front of the store! I repeat: all Shop-Rite specialists to the front of the store!"

It took some doing for the specialists to reach their goal. Nobody in line was about to relinquish his place despite the plea, "Coming through, please, coming through." The specialists endeavored to assure the agitated shoppers that it would be to their ultimate advantage to step aside.

I recognized them as the product representatives who earlier had been supervising the stock boys stacking the rapidly emptying shelves. All were garbed in business suits, conservative ties, and deep frowns. They appeared to be out of their element in the role of cashier which they assumed presently.

Other employees shoved through the crowds and tapped those whose carts contained ten items or less. These lucky ones were advised, "Take your selections to the liquor department."

The liquor department cash register was not wired to the unfortunate computer system; smaller orders could be handled there. This proved to be token assistance, as most shoppers had stocked up for the week, but at least some in the crowd would be dismissed promptly. One man, overlooked for transfer to the liquor counter, tugged at an employee's sleeve. "Hey, buddy, How about me?"

The employee surveyed the cart, then relented, "O.K. Go ahead. You have only fourteen items."

An elderly lady near me, prim and genteel of mien, had six selections in her cart. "You can be waited on at the liquor counter," I prodded her, believing she had not understood the directive.

"Never!" she retorted. She was adamant. "You'll not catch me near a drop of liquor!" Doggedly, she stood her ground behind eight carts brimming with groceries.

Ugly dispositions began to flare. A pugilistic man far to the rear of our line took exception to the liquor counter decision. Why should customers with small quantities be serviced and the rest penalized? Mouthing his protest in X-Rated terms, he rammed his heavy cart into the person in front of him. The chain reaction of cart into flesh reached me moments later, resulting in a raw heel and a run in my stockings. By the time all the victims in our line consolidated their ire, the culprit had melted into the mob.

Another chain reaction erupted as a wave of furious customers abandoned their carts willy-nilly and stormed out the doors. En route, they verbalized their resentment for the indignities being thrust upon them. Several enjoined the rest of us to follow suit. "Let's show the management we mean business," one agitator cried.

A few more stoic customers were embarrassed by the actions of the rash ones, and a girl asked me to guard her place in line while she did the very least she could do as a concerned citizen: return the meats and frozen foods in the abandoned carts to their proper counters.

The compassionate girl need not have worried about losing her place at the checkout, for we were in the identical spot when she returned. The customers who remained—and there were dozens, even hundreds—seemed resigned to waiting out the ordeal. However, most made it vivid to everyone within earshot that they had no intention of revisiting the premises. One man put it succinctly: "It's bad enough being trapped in a Grand Opening mob, but it's an aboslute crime to be kept prisoner by a broken-down machine."

He vowed to scrutinize henceforth each market he enters to make certain it features "... good, old-fashioned cash registers." These, he pointed out, might individually cease operation on a whim, but odds are they will not *all* go on the blink at once.

Several husband and wife duos began bickering as to whose idea it had been to shop at this store. One man accused his wife of being unable to resist a Sale, and she retorted that if he were not such a poor provider she would not be forced to buy at Sales and Grand Openings in order to live within his lousy salary.

Numerous epithets were noised abroad, all hinting darkly of conspiracy in high places, infiltration of the Mafia into the computer industry, and a secret move afoot to subdue the public. The general consensus was that computer programming is the initial step toward the dehumanization of mankind, and if we submit to its authority, it will be no time before the communists who design and manufacture computers invade our private dwellings and spy on personal activities.

One man, gifted with sonorous delivery, decried the implementation of computers in any capacity and spewed his hatred equally between computers which seldom operate properly to those which soon will be planted covertly on our very persons. His captive audience tended to concur with his prophecy, although their bewildered faces clearly reflected a failure to trace his blustery line of reasoning.

Up ahead, two adding machines, newly located, had been moved into position at two counters. Computation at the other eight aisles would be done by pencil and paper. In short, third grade arithmetic was rushed to our rescue.

Hope soared when a computer specialist arrived on the premises, but he promptly reported that the problem hovered within the jurisdiction of an electrician. It was anybody's guess when one would arrive.

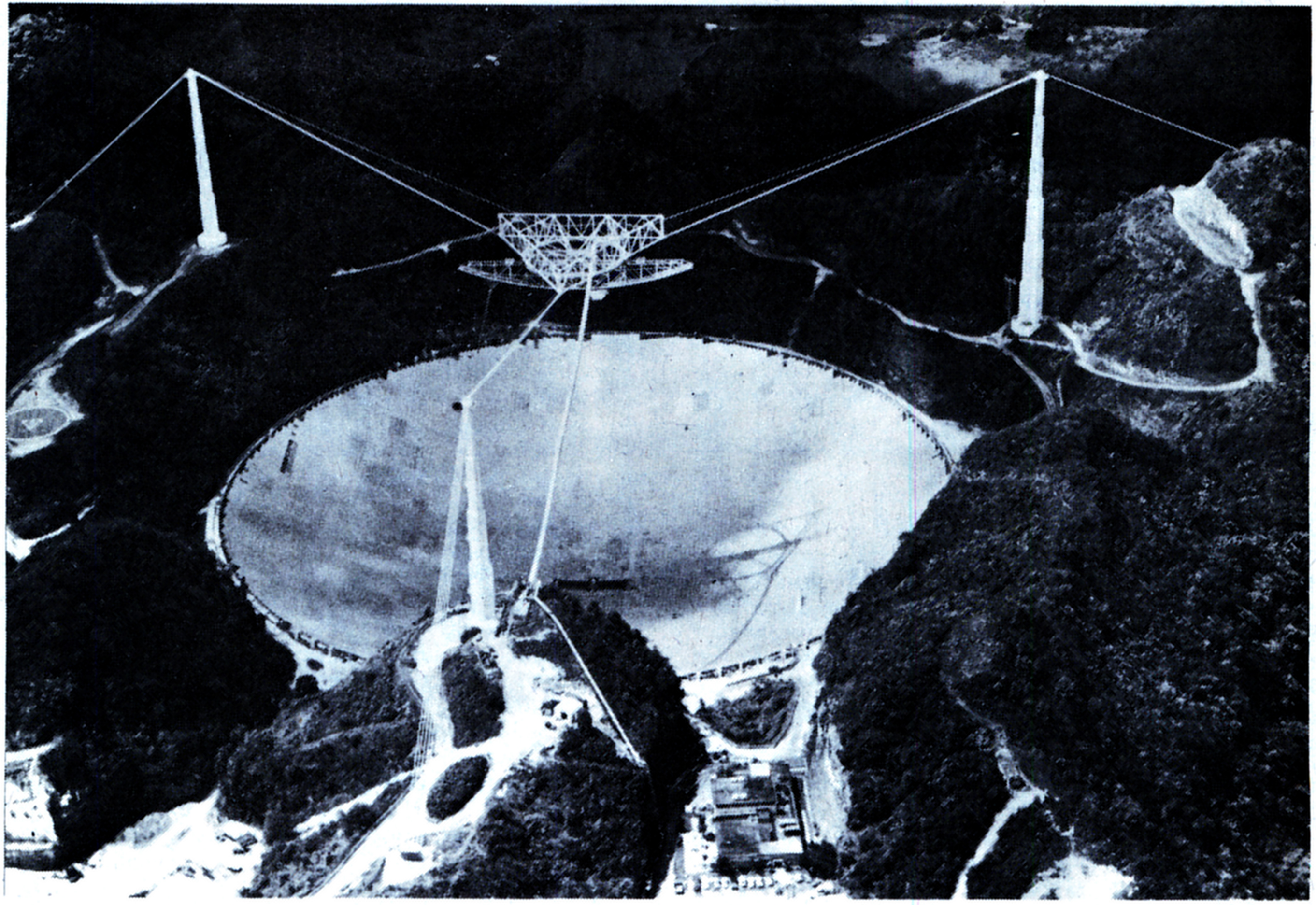
No matter, I detected a faintly perceptible forward motion of our line. The child whose balloon had been demolished was still whimpering, but his mother buoyed him with hope. "They're moving along now. See, the man is adding up the groceries with his crayon. Hush! Maybe we'll get out of here some time tonight." Then, more sternly, "If you don't shut up, the man won't let you out of here!"

Inch by inch, item by item, we battled our way to the counter as the Shop-Rite specialists patiently added column upon column of figures. Sometime after 6:00 P.M., my order was tallied and packed snuggly in eight brown bags.

Mayhem persisted throughout the Grand Opening weekend, my neighbor reported, despite the fact that three registers returned to service late Friday evening. I shall not belabor her adventures in the store except to report that she is convinced the world will arrive at a standstill soon thanks to hysteria born of malfunctioning computers.

Today the Springfield Shop-Rite Super Market basks in the glory of an operational automated check-out system, but one cannot help speculating when and where the public will be treated to the next nightmare sparked by a capricious computer gremlin.

An editor read this story and commented, "How clever, it sounds almost real" The reason it sounds real is because it actually happened and every detail in this account is absolutely true.



An Ear On The Universe

by John Lees
University of Missouri—Rolla

Nestled in a natural limestone sinkhole in the jungle covered mountains of northern Puerto Rico is the largest radio telescope on Earth. Its reflector is a spherical bowl 1,000 feet in diameter — a surface area of 20 acres. The telescope is steered by repositioning the 600 tons of receiving and transmitting equipment, which is supported 50 stories in the air on cables anchored by three massive reinforced concrete towers. Each of the towers is guyed to ground anchors with five 3.25 inch steel bridge cables. When the Arecibo reflector is used as a 2380 MHz S-band radar transmitter its effective power output is 100 trillion watts. When used as a receiver for the radar echoes its sensitivity is one-100 million trillionth of a watt; a span of 34 orders of magnitude.

The Arecibo Observatory in Puerto Rico is part of the National Astronomy and Ionosphere Center operated by Cornell University. Constructed in 1963 at a cost of $9 million, the telescope's reflector originally consisted of a bowl of wire mesh supported by cables slung from the edge of the reflector bowl. It was not thought that the receiver-transmitter platform would be stable enough in normal winds and temperature changes to make it worthwhile to have an extremely accurate reflector bowl, since the aerial platform was expected to sway as much as one and one-half inches.

When in 1966 Puerto Rico lay in the path of Hurricane Inez these original expectations proved to be far too conservative. In the sixty-two mile-per-hour winds of the hurricane the platform was observed to sway less than half an inch. This meant that, under normal weather conditions, the platform could be expected to sway less than three-tenths of an inch. Because of these findings it was decided to upgrade the accuracy of the reflector curvature to match the stability of the receiver-transmitter platform.

With the backing of the National Science Foundation and the National Aeronautics and Space Administration this task was begun. An additional $8.8 million was spent to improve the accuracy of the reflector, improve the receiver-transmitter platform, and increase the power of the radar transmitter. The reflector surface now consists of 38,778 specially designed aluminum panels, each of which has on it a white square used as a target for the laser surveying system. This laser system permits the entire surface of the reflector to be surveyed to an accuracy of better than one millimeter. The panels are individually adjustable to keep the reflector as spherical as possible. The reconstruction was completed in November of 1974.

The History Of Radio Astronomy

Radio waves were experimentally demonstrated in 1888 by Heinrich Hertz and a few unsuccessful attempts were made shortly thereafter to detect radio waves from the Sun. Early receiving equipment was of low sensitivity and the effect of the upper atmosphere on radio waves was poorly understood or even completely unsuspected. Some progress was made in the 1930s, mostly as a byproduct of communications research or through the efforts of a few dedicated hobbyists, but the real progress did not begin until World War II brought the use of radar and military communications systems.

During the war several things combined to open the way for radio astronomy. A great deal of basic research was being performed by the scientists working on wartime radar installations. It was at this time that it was discovered that sunspots could interfere with radar operation. In England, problems were encountered with cosmic background noise and with upper atmosphere noise when systems were being developed for detecting the V2 rocket. Research in these vital areas was of course encouraged. The armed services also supported a good deal of spin-off research in such areas as the radar detection of meteorites and the reception of radar echoes from the Moon.

The universe outside of our little solar system abounds with mysteries and discoveries which stretch the mind's ability to comprehend.

The advances made during the war in electronics, radar, radio and all branches of technology had a vast impact on the resumption of scientific research in 1945. Many researchers had received new insights, formed new associations, or uncovered entirely new areas in which to do research. Sophisticated war surplus equipment was easy to come by and the armed services were quite willing to cooperate with the scientists who had been so much help during the war. Technology had been given its biggest push; it was not about to slow down.

Radio astronomical research blossomed in England and Australia and slowly spread to other countries. Jodrell Bank in England began with war surplus radar equipment. Research in Australia was the direct outgrowth of a group formed during the war. The U.S. Naval Research Laboratory initiated research in short wavelength radio astronomy, completing in 1950 the first large radio telescope designed specifically to operate at centimeter wavelengths. By the end of the 1940s most countries had established radio astronomy research groups. In the early 1950s several vital discoveries, such as detection of the 21 cm hydrogen line, laid a firm foundation for the expansion in research which turned into a boom with the coming of the space age. There are now at least as many major radio astronomical observatories as there are optical observatories. Computer techniques in pattern recognition and information theory have been of great help in radio astronomy and have made possible some of the newer synthesized radio telescope arrays.

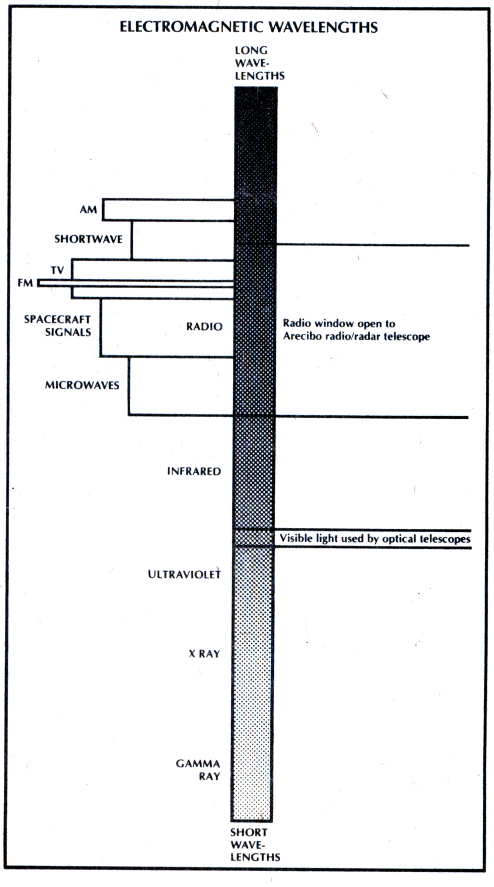
Discoveries In Radio Astronomy

A radio telescope differs from an optical telescope in the portion of the electromagnetic spectrum to which it is sensitive (see figure). Optical telescopes are used around the narrow band of frequencies to which the human eye is sensitive. Radio telescopes, however, are sensitive to a much broader range of frequencies. A radio telescope can be used day or night and is not bothered by an overcast sky or smog. Radio telescopes can also see into parts of the Universe which are blocked to optical telescopes by interstellar dust clouds. Some radio telescopes, such as the one at Arecibo, are also powerful radar transmitters and can bounce radio waves off satellites, asteroids, nearby planets, the Sun and particles in the Earth's atmosphere.

To a radio telescope, the sky looks totally different than it does to the human eye on a dark night. The visual brightness of a star in the night sky has little to do with its radio brightness. Familiar stars no longer look the same. The constellations are gone. The planets, themselves not strong emitters of radio waves, are almost invisible. The Milky Way is much brighter at radio frequencies and there are a multitude of new objects to be observed in the sky. But cosmic radio sources are still very faint. It is said that celestial radio signals reaching Earth are so faint that all the energy collected in the forty-year history of radio astronomy is about equal to that released when a few snowflakes fall on the ground.

Since it began operation, the Arecibo Observatory has yielded an astonishing amount of information about our solar system, our planet and our universe. The Arecibo telescope has heard more that 3,000 separate radio sources, only about 100 of which have been identified optically. Many of them will never be optically identified from Earth; they are simply too weak in the optical portion of the spectrum. Some of the radio waves received at Arecibo have been travelling nearly ten billion years on their way from the edge of space to Earth.

Radio maps of the Moon produced before the lunar landing missions predicted that the Moon's surface would be covered with a thick layer of dust. The close similarity between radar and optical maps of the Moon indicate that radio reflectivity and light reflectivity are probably close enough to allow accurate mapping of the planets. Extensive mapping of the surfaces of Venus, Mercury and


ELECTROMAGNETIC WAVELENGTHS
LONG WAVE-LENGTHS
AM
SHORTWAVE
TV
FM
SPACECRAFT SIGNALS
RADIO
Radio window open to Arecibo radio/radar telescope
MICROWAVES
INFRARED
Visible light used by optical telescopes
ULTRAVIOLET
X RAY
GAMMA RAY
SHORT WAVE-LENGTHS

Celestial radio signals reaching Earth are so faint that all the energy collected in the forty-year history of radio astronomy is about equal to that released when a few snowflakes fall on the ground.

Mars is planned, along with looks at the asteroid belt, the four major satellites of Jupiter and the rings of Saturn. It is also possible to look "under the surface" with radar, showing the terrain which lies below a layer of dust.

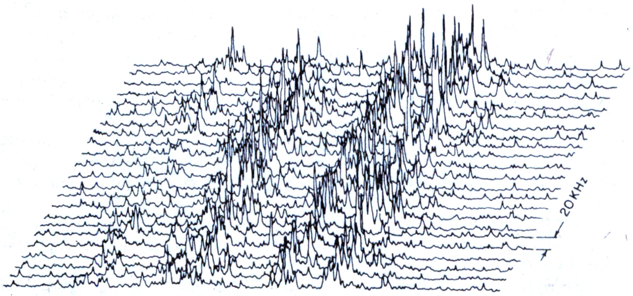
Venus, Earth's sister planet with the eternal cloud cover, has been a source of mystery and the target of sometimes wild conjecture for many years. In 1964, radar signals from Arecibo were used to accurately determine Venus' period of rotation and confirmed the theory that Venus, alone of all the planets, spins on its axis in a clockwise, not counter-clockwise, direction. It was later also determined that Venus exhibits the phenomenon of "Earth lock." Each time Venus swings by Earth, it turns the same face toward Earth. In 1968, Arecibo produced its first radar map of Venus.

Mercury, the closest planet to the Sun, completes an orbit every eighty-eight days. Until 1965 it was thought that Mercury always kept the same face turned toward the Sun. Radar studies by astronomers at Arecibo showed that Mercury did, after all, rotate slowly on its axis, turning alternate faces to the Sun at each close approach. Beginning in 1970, the Arecibo radar has been used to map portions of Mercury, showing the planet's surface to be rougher than that of Venus but not quite as rough as the Moon.

The universe outside of our little solar system abounds with mysteries and discoveries which stretch the mind's ability to comprehend. In 1967 a British survey of twinkling radio sources turned up radio pulses of startling regularity coming from a certain direction in the sky. The Cambridge, England team which made the discovery did not release the news of the discoverey immediately because of debate over whether the pulses might be signals from intelligent beings elsewhere in the Galaxy. After several weeks this possibility was largely discounted and the theory advanced that the pulses were coming from a rapidly spinning neutron star.

Conclusive evidence against the possibility of pulsar signals being intelligent interstellar communication came from the Arecibo discovery that the pulse interval was increasing by some 36 billionths of a second a day. This was confirmation of the theory that pulsars are neutron stars, since such a rotating star should be gradually slowing down.

Neutron stars, theoretically predicted in 1933, are the remnants of giant stars which have collapsed to a radius of about 10 km while retaining approximately the mass of our sun. This results in a density of some 10^{14} g/m^3, the density of an atomic nucleus. (For an exercise in the mind's inability to comprehend large numbers, try to imagine one cubic inch of matter with a weight in excess of ten billion tons! Of course such a density can only exist under the terrific pressures found within a collapsed star.) In some way which is not yet completely understood, the intense magnetic field of the rotating neutron star generates beams of coherent radio waves and light which appear as pulses to an observer on Earth.



ANATOMY OF A PULSAR PULSE

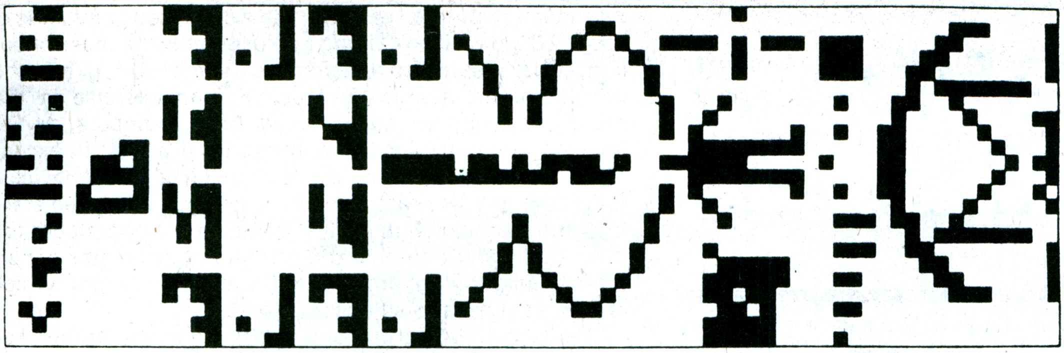
Perhaps the most famous pulsar is the one in the Crab Nebula, which was observed and recorded by the Chinese as an explosion in the year 1054 A.D. A nebula is a still-glowing cloud of interstellar gas and dust, the remnant of a supernova, or stellar explosion. The Crab Nebula pulsar also emits light pulses and has been optically identified as the exploded supernova.

The Arecibo Observatory continues to do research on pulsars and is also participating in the search for black holes. Without a doubt one of the oddest celestial bodies, a black hole is the super-dense remnant of a giant star which has collapsed in such a way that it almost no longer exists. Past a certain limit the gravitational field of a black hole does not permit any interaction with the rest of the universe. A beam of light, or anything else, will "fall into" a black hole and never come out. Black holes are unescapably predicted by the general theory of relativity, but their existence has not yet been observationally verified. Of course one must use indirect methods to "observe" a black hole, such as noting the apparent influence of a large mass on a stellar system when no such mass is observable with an optical or radio telescope. Interestingly enough, something like a black hole was predicted in 1795 by Pierre-Simon Laplace.

Of all the things which may exist outside the bounds of our planet Earth, surely the most wondrous of these is life itself.

In addition to pulsars and black holes, there are a multitude of other interesting objects Out There — several other types of radio stars, several types of radio galaxies and, the most distant known objects in the Universe, the quasars, or quasi-stellar radio sources. Receding from us at more than half the speed of light, quasars are whole galaxies in which a very small part (only light-weeks in diameter) releases tremendous amounts of energy equivalent to the total annihilation of millions of stars. Quasars emit enormous quantities of radio energy which, traveling at the speed of light, have taken as long as ten billion years to reach Earth.

Although the 1,000 foot dish of the Arecibo radio telescope is physically the largest on Earth and there are now several radio astronomical observatories using multiple antennas with their signals combined by computer in such a way as to synthesize antennas of more than a kilometer in diameter, there are very distant or very small objects (such as quasars) which can not be adequately measured with a single radio telescope. To make such measurements a technique known as long-baseline interferometry is used. This involves combining the signals from two or more radio telescopes, often on opposite sides of the Earth, and using computers to process the signals to yield data not obtainable with a single radio telescope. Pioneer work in this area was done in 1966 by a team which included a Cornell professor and made use of the Arecibo Observatory.



This is Man on Earth Speaking to Space, the message beamed from Arecibo Observatory to M-13.

Life In The Universe

The Universe is a rather large place, large enough to contain all the wonders imaginable and quite a few which we have not approached in even our wildest dreams. Of all the things which may exist outside the bounds of our planet Earth, surely the most wondrous of these is life itself. The search for extraterrestrial life is an exciting and important part of radio astronomy.

Scattered through interstellar space, between the stars and dust clouds, are isolated molecules of materials such as hydrogen, formaldehyde and methyl alcohol — some of the basic ingredients of life on Earth. The Arecibo radio telescope can be used to gather data for analyzing and quantifying these molecules, as well as to search for other freely floating chemicals. These chemicals may very well be the seeds from which life on Earth evolved. Important confirmation of this theory may come when the *Viking* landers conduct the first rigorous search for life on Mars in the summer of 1976.

If life has evolved on the planet Earth, in our solar system, why may it not have evolved elsewhere in the Universe? There are some 200 billion stars in our Milky Way Galaxy alone. It is now fairly certain that a number of stars, at least in our part of the Galaxy, have planets of about the mass of Jupiter. Present methods can not detect less massive planets in orbit around other stars, but it is generally accepted that stars with planetary systems are not exceedingly rare. Surely, on some of the other planets in our galaxy, the correct conditions have obtained for life of some sort to begin its slow way along the evolutionary process. Among 200 billion stars, odds of even a million to one begin to look rather plausible.

The most exciting possibility of all is that there may not simply be life elsewhere in the Universe, but that it may be intelligent life. There are billions of stars in our galaxy and there are billions of galaxies in our universe. It is not so difficult to believe that intelligent beings inhabit more than one planet in this vast universe. Some of these beings have probably reached the same level of understanding of natural phenomena as have human beings; some are more, and some are less, advanced. With all of them we must feel the most basic kinship and a yearning to know for certain that we are not alone in the face of the vastness of the Universe.

Listening For Intelligence

It is indeed tantalizing to think that, right now, like an inaudible whisper, radio messages from light years away are falling into the valley of the Arecibo reflector bowl — messages that could be heard if their direction and frequency were known. When the upgraded Arecibo radio telescope was dedicated on November 16, 1974, a message was sent commemorating the occasion. Our first intentional attempt at radio communication with extraterrestrial life is now travelling at the speed of light through the Milky Way toward a globular cluster of some 300,000 stars known as M-13. It will take about 25,000 years to reach its destination. Any reply will take as long to return to Earth. Although the message was beamed from Arecibo for only three minutes it is entirely possible that one day a reply will be received. (see figure)

In the meantime, it is within Earth's technological ability to decide the question of whether there are other beings Out There trying to communicate with each other and with us. No more stupendous moment in the history of the Earth can be imagined than the first intellectual interchange with an intelligence other than our own. The Arecibo radio telescope is now the premier instrument in the world for such an undertaking. Given careful planning and an adequate observing program, there is a genuine probability that this most important of frontiers will be crossed for the first time.

M-13 Response Received

Less than 10 days after a formal announcement of life on earth was beamed toward a far-off cluster of stars known as M-13 from the Arecibo Observatory in Puerto Rico, an "answer," purported to be from outer space, was received.

Cornell professor and director of the National Astronomy and Ionosphere Center (NAIC) Frank D. Drake who, with his staff, initiated and composed the "life on earth" message, received this answer by telegram Nov. 25:

"Message received. Help is on the way. —M-13." It came through on the NAIC telex machine in Ithaca via the International Telephone and Telegraph system. The true identity of the sender has not been confirmed, but Drake suspects that it may have come from practical jokers on the observatory staff at Arecibo.

Thanks to Cornell University and the National Astronomy and Ionosphere Center for permission to use illustrations and to make extensive use of published material on the Arecibo Observatory.

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COMMUNICATION ACROSS THE UNIVERSE

by Martin Harwit
Space Sciences Department
Cornell University

In the past few years a number of messages have gone out from Earth in the hope that an advanced civilization might find them. We also have searched cosmic sources of radiation for signs of extraterrestrial intelligence but have not yet found any.

We are faced with two questions:
What are the best ways for us to transmit messages?
What are the best strategies to employ in searching for messages?

The answers are not simple.

In writing an ordinary postcard, we have to consider three different factors. We have to decide to who to write, what to write and how to convey the card. These same decisions — not necessarily in the same order — are also involved in cosmic communication.

First, we must decide on the best channel of communication. If we plan to transmit, should we deliver our message by interstellar rocket, should we employ a modulated laser beam flashing coded signals, or is there some method far superior to either of these?

Once we decide how the message is to be conveyed, we must decide on the language to be used. Surely it won't be English, or Chinese, or even Fortran. The intended recipients won't know English or any other terrestrial tongues. How can we establish a common language understandable to all?

Lastly we have to decide on an address: If we knew how to choose a civilization that is alive and active today, would it still be around tomorrow? In fact, what is the life expectancy of a technically advanced civilization? Judging by recent Earth history, the step from the development of elementary radio transmission techniques to an ultimate nuclear explosive extinction of Man may last just one short century. If that is common, we had best make our message quite short and to the point. And we should forego asking for a recognition sign; we may not be here to receive it.

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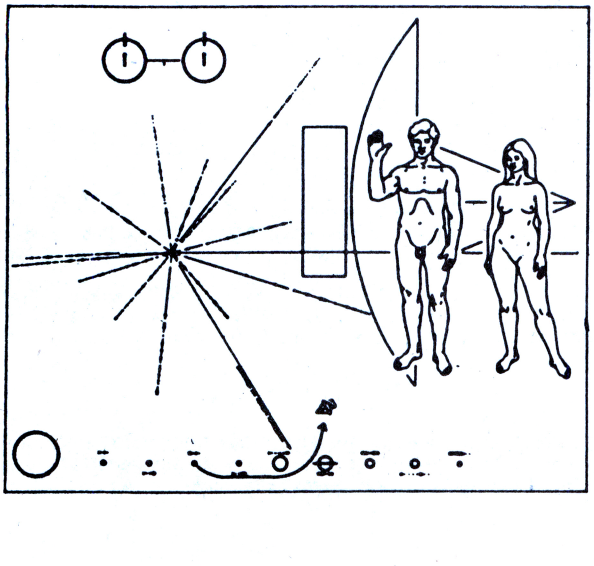

Let us first look at the optimum channel for communication. Basically this is dictated by the structure and contents of the universe we inhabit. If the universe were different, our options also would differ. Consider, for example, the messages carried by the spacecraft Pioneer 10 and 11. Each of these vehicles carries a plaque that describes the location of our planet in the Milky Way galaxy, and describes the inhabitants of Earth.

What are the chances that these two plaques will ever be discovered? I think the odds are very low. There is not so much doubt that a sophisticated civilization would have the ability to detect the spacecraft. Rather there is uncertainty about the ability to recognize them:

We know that roughly once a year the solar system ejects a comet nucleus about a mile in diameter. For each of these large chunks of matter there are probably thousands, and perhaps millions, of smaller fragments that also find their way out of the solar system. In the past billion years alone, a billion mile-sized comet nuclei and countless smaller chunks have left our solar system. In this confusion of debris, how is any civilization going to pick out two tiny Pioneer spacecraft as having especial significance? Certainly, success will require a formidable effort. The Pioneer 10 and 11 probes are therefore basically addressed only to the most sophisticated and ambitious civilizations. That happens to be the best we can hope to do right now, but as our technology develops we should be able to do far better.

In the past billion years alone, a billion mile-sized comet nuclei and countless smaller chunks have left our solar system. In this confusion of debris, how is any civilization going to pick out two tiny Pioneer spacecraft as having especial significance?

Similar questions of confusion arise when we think of communicating by radio or by means of visible lasers. The prime constraint is seldom the sensitivity of the detector. Instead, we are mainly limited by the profusion of signals emitted from natural astronomical sources. The detection of a message from another civilization requires means of discriminating against all this noise.

If we inhabited a quieter universe, in which there were far fewer bright astronomical sources, this problem would be less severe. On the other hand, perhaps there would also be correspondingly fewer intelligent civilizations in the universe.

The optimum means for transmitting signals also depends on the urgency of a message. Spacecraft are rather slow. At best they can approach the speed of light if we are willing to budget for the high expense of accelerating these craft. Even if we do, the destruction rate through collisions

One other carrier of information might exist in the form of the faster than light tachyons.

with naturally occurring interstellar debris increases dramatically with increasing speed, so it is not clear how well high speed spacecraft could survive prolonged interstellar voyages.

Electromagnetic signals, or signals employing gravitational waves and neutrinos all travel at the speed of light. At that speed a message can reach the nearest stars in a matter of years, the center of our Galaxy in thirty thousand years, and the nearest galaxies in some millions of years. Two way conversations would have to be correspondingly slow. Just now electromagnetic waves may look like the best bet because we do not yet know how to receive or transmit gravitational waves, and the transmission and reception of neutrinos is discouragingly inefficient. But all that may change.

One other carrier of information might exist in the form of the faster than light tachyons. Tachyons are hypothetical particles which may very well not exist at all. We just don't yet know. However, if they do exist, they would be priority choice for urgent messages. They could be transmitted at such high speeds that two-way conversation might be practical in some instances. Tachyons, if they can be generated, would take advantage of a loophole in the laws of relativity. Einstein's special theory states that no particles can be accelerated up to or beyond the speed of light. However, it does not state that particles can't be generated directly at these high velocities. Just as two colliding photons can give rise to a pair of particles such as an electron and a positron or a proton and an antiproton, both travelling at velocities well below the speed of light, so also we can imagine two photons colliding and giving rise to a pair of tachyons. We do not yet know how to detect these entities, but as long as we remain uncertain about their existence, we will be ignorant of what might well be the most promising channel for interstellar and intergalactic messages.

* * * * * * * * * *

We now turn to the language to be used. Two ideas have been widely discussed in this context. The first involves pictograms — simple pictures that might be easily understood. The second concerns artificial languages that are self explanatory.

This second approach is particularly interesting. The most extensively developed language of this kind is *Lincos* developed by the mathematician Hans Freduenthal at the University of Utrecht. In essence, he starts out with a list of symbols representing one dot, two dots, three dots, . = *1*, . . = 2, . . . = 3, and so on. He then lists examples of addition. Essentially

1 + 1 = 2
1 + 2 = 3
2 + 1 = 3
1 + 1 + 1 = 3
and so on.

This defines not only mathematical relations, but also the concept of equality that is a common part of our social thinking. Symbols like < and > are similarly defined by lists of numerical examples and eventually work their way into such concepts as greatness, prominence, and so on.

In principle such a language can go on to physics, for instance, by listing the relative masses of all atoms and nuclei known to be stable. Every advanced civilization will know the values of these masses which bear a nearly — but not quite — integer relationship.

And once the elements are defined a further listing can show elementary chemical reactions and structures including those that are fundamental to our existence — metabolic processes and genetic structure. Beyond this stage a message can become encyclopedic. For, it is really the fundamental structure of the language that is most difficult to establish. Once that is accomplished, more sophisticated concepts can readily be added in any quantity.

The problem of constructing intelligible pictograms is somewhat different. Such pictures consist of light and dark squares arrayed very much like a television picture. There are mn elements — where m and n both are prime numbers. With this choice of prime numbers there are only two ways that a rectangular array — picture — can be obtained: a picture with n rows and m columns, or one with m rows and n columns. If m = n the picture is square and unique except for a left-to-right, up-down ambiguity.

Proponents of pictograms often do include some elementary arithmetic and chemical concepts in their pictures, but they rapidly go on to show more sophisticated ideas, a picture of man or a sketch of the solar system.

Whether such pictures are intuitively obvious is not really clear. Our own intuition is so strongly conditioned that such messages are likely to be quite fundamentally prejudiced to the extent of being incomprehensible to an alien civilization.

The first reception of extraterrestrial messages no doubt will involve great difficulties and major technical advances. However, once this initial barrier is overcome a whole new social era could begin.

Ultimately the pictograms should be subject to exactly the same need for logical development as any other language, and I imagine a properly designed interstellar message is likely to contain both a preliminary developmental chapter that defines the language, as well as a message that may be partly in the form of words, and partly illustrated by pictograms.

* * * * * * * * * *

The final question to be considered here is whom to address. Or whom to expect to transmit.

If we believe that life can only exist on planets, then we might first transmit messages to the nearest known planetary systems or search for messages emanating from these nearest neighbors. Such messages might consist of individual symbols (letters, numbers) each transmitted for a period lasting anywhere from seconds to hours.

On the other hand if, as Frank Drake has pointed out, some forms of life could exist on a neutron star where temperatures are far higher than on Earth, metabolic rates could be speeded up a million-fold. Such a civilization might then transmit messages at a rate of a million symbols a second. The problems of transmitting and receiving at these speeds would not necessarily be more difficult for us, but we would have to be aware of the great range of possibilities. Not only would we have to worry about the language to use, the contents to be transmitted and the means of transmitting, we even would have uncertainties about how "fast to talk."

The first reception of extraterrestrial messages no doubt will involve great difficulties and major technical advances. However, once this initial barrier is overcome a whole new social era could begin.

Isaac Asimov

The Cosmic Subway Line

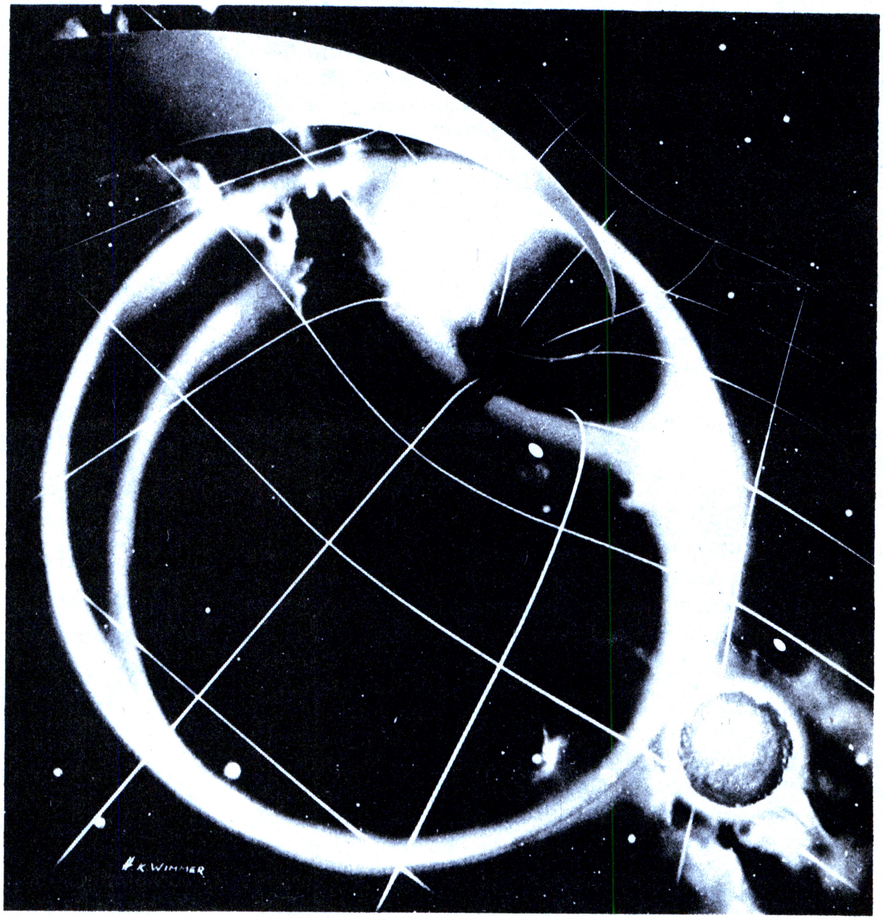

ILLUSTRATION BY HELMUT WIMMER

Artist's conception of a "black hole" in space.

The most exciting phenomenon in astronomy these days is the black hole—an apparent final graveyard of matter, thanks to its gravitational field. There are only four kinds of forces known to exist in the universe, and gravity is by far the weakest of the four—but wait.

Two of the forces are very short-distance phenomena that involve only subatomic particles and aren't felt outside atomic nuclei, ordinarily. A third one, electromagnetism, is long-distance, but expresses itself as an attraction under some conditions and a repulsion under others. The two tend to cancel each other, so that electromagnetism never manages to display really great intensity.

Gravity is different; it shows itself as a long-distance phenomenon, and only as an attraction. The more matter you pile together in one place, the greater its gravitational field becomes. If you start with a certain amount of matter and squeeze it together more and more tightly, the stronger its gravitational field becomes. Either way (or in combination), a gravitational field can be made greater than any other force can possibly be.

As gravitation becomes extreme, all matter within its influence breaks down. Atoms and even subatomic particles squeeze down to nothing. Anything that falls into a sufficiently intense gravitational field can never come out at the point it entered, so that the field acts as a "hole." Even light can't emerge, so it is a "black hole."

A black hole can form when a large star explodes and collapses. Astronomers think that an object they call "Cyg X-1" is a large black hole in our own galaxy. It may be that there are black holes of all sizes distributed all

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over the universe. Even "mini-black holes," perhaps of no more than pinpoint size, may have formed in the great explosion that produced our universe in the first place.

It would seem that all matter will eventually fall into one black hole or another, until only black holes are left, and that this would represent the final end of the universe. Such an end is many billions, perhaps trillions, of years in the future, however, and meanwhile black holes could, conceivably, be put to use.

Objects spiraling into black holes gain vast energies of motion from the black holes' gravitational field, and some of this energy is converted into intense radiation. An advanced civilization (we ourselves someday, perhaps) may set up outposts near a black hole—but not too near, of course—in order to tap this overflow of energy.

We might even imagine methods devised to force wandering objects closer to the black hole, close enough to push them into the ultimate inward spiral from which they will never return, and, in the course of which, floods of usable energy would be emitted, absorbed and stored. The black hole would thus be treated as a huge furnace for which any sort of matter whatever would serve as fuel.

But what happens to matter that enters a black hole? Some astronomers think it isn't really lost forever but is extruded like toothpaste into another part of the universe. At the point of emergence, it would expand and blaze with energy as a "white hole." Perhaps the mysterious quasars, far-distant objects that gleam with the light of a hundred galaxies at once, are white holes.

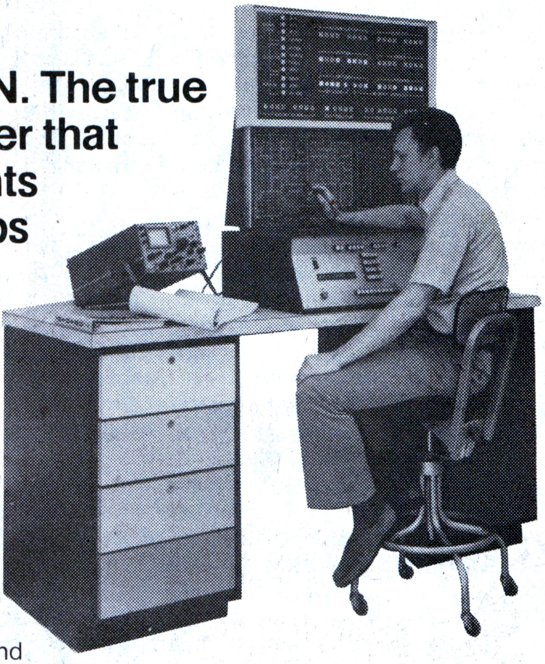
Under the extreme conditions of the black hole, matter may travel from one place to another very-far-distant place in very little time, transcending the speed limitations of the ordinary universe.

The Cornell astronomer, Carl Sagan, wonders whether the day might not come when mankind would learn enough about black holes to devise methods for surviving the conditions within them. Perhaps special gravity-resistant ships, using scientific principles undreamed of today, could carry men and goods through black holes to that distant terminus at the other end.

It may be that there are many black holes (Sagan estimates perhaps as many as a billion in each galaxy, and that the average distance between them is forty light-years, just a hop and a jump on the cosmic scale) and that each represents a different route, going from some particular place to some other particular place. Little by little, mankind might be able to map out the routes of these cosmic subway lines and work out schemes for traveling from any point in the universe to any other point by some appropriate combination of black holes.

Or perhaps some other, more advanced, intelligence (or groups of intelligences) in the universe, has already succeeded in doing this. Perhaps a Cosmic Empire exists, with prosperous industrial planets located not too far from some black hole terminus. It may be, then, that we won't have to map the universe at all, but that, when the time comes and we are sufficiently advanced, we may simply join the Cosmic Empire and become full members of the universe at once.

If it is true that black holes represent not the death of matter, but its death-and-resurrection, the universe would last forever. And with it, the various intelligences, including mankind's, might last forever as well.



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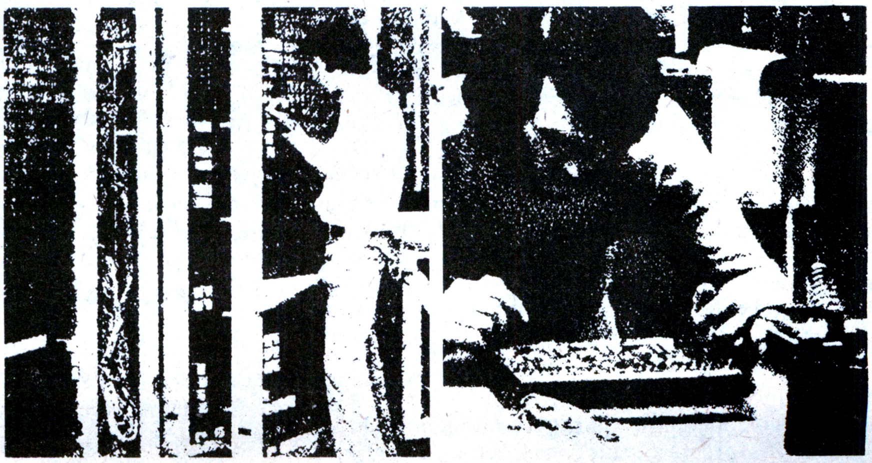

GEOMETRIC PROOFS

by Thomas J. Kelanic
Project SOLO and
Taylor-Allderdice High School

It has bothered me for over a decade that I cannot personally check each of the 300 or more geometric proofs my students submit to me as daily homework. Consider that any high school geometry teacher may have a hundred students to whom he may assign three or more proofs for homework. Can the teacher read and analyze each potentially unique theorem produced? Can the teacher spend enough time on each proof to diagnose and correct the errors he may find? Can each student see what he did wrong when one correct proof of each theorem is placed on the chalkboard? Can the student who has written an "off-beat" but valid proof receive approval? Does the student get enough feedback from his own paper as he writes his proof? Is the student aware of the alternatives open to him at each step in his proof? Does the student feel a sense of direction as he writes his proof?

I believe the program I have written is an important step forward in attempting to provide an affirmative answer to all of the questions above. My first conceptualization of the program was stimulated by an article describing pattern-matching of "relation-chains" using "keywords" in a man-machine dialogue by Rockart, Morton, and Zannetos (1971). The SITBOL improvements by Gimpbel (1972) of the SNOBOL4 programming language of Griswold, Poage, and Polonsky (1971) seemed to me to provide the best medium for expression of the concept.

The program provides "dynamic" proof construction capability which may enable a student to write three or four proofs in a 45-minute period. The run shown, for example, took 12 minutes of terminal time. By "dynamic," I mean that the program will perform the following functions:

1. Examine student input for proper vocabulary and word sequence. Faulty sentences are ignored; a diagnostic message is issued; and another opportunity for input is presented.
2. Examine student input statements for logical validity; that is, verify that the statement is a given assumption, a valid conclusion from previous statements, or a postulate or property which is accepted as true independently. Invalid statements are identified and rejected, and another opportunity for input is presented.
3. Validate reasons given by the student for each statement he inputs. If the reason is incorrect, the correct reason is output and reference is made to the previous statements which support the conclusion.
4. Output all valid conclusions which are implied by the new statement in combination with any of the previous statements. The student may then elect to input one of these conclusions as a new statement.
5. Provide for student control through the use of student commands such as the following:
    a. "REVIEW" to review all previous statements.
    b. "TOTAL" to review all previous conclusions.
    c. Backslash (\) to ignore faulty input.
    d. "PROVE" to exit the "givens" loop.
    e. "QUIT" to terminate program execution.
6. Output the proof in standard two-column format and give a tally of invalid statements and erroneous reasons, if any.

Although the program is incomplete, it works. The basic interactive concept of the program has been firmly established. The program functions "dynamically" and adds a kinetic element to the study of implications. The student can witness an implication as an event. The student can exercise his control over these events, and can pursue, in partnership with the program, many alternative routes during proof construction. The use of statement number references in reasons can leave little doubt in the student's mind as to which statements were the cause of the conclusions produced and why. The student will find it desirable to learn the postulates when he realizes that they are simply unstated "givens." The program presently uses 10 implications which represent a few definitions, theorems, and properties selected not on the basis of geometric precedence, but on the basis of programming challenge. In addition to these 10, one property that does not behave as an implication, the reflexive property of congruence, is used. Before testing the program on students, further development of the program will be continued.

EXAMPLE SHOWING USE OF THE PROGRAM

In the sample run which follows, all student input has been marked by a heavy arrow (⟵) to aid interpretation by the reader. The program itself, which was written in SNOBOL4, is not shown since not many schools have this language. (A future project will be to try to write the program in BASIC-PLUS).

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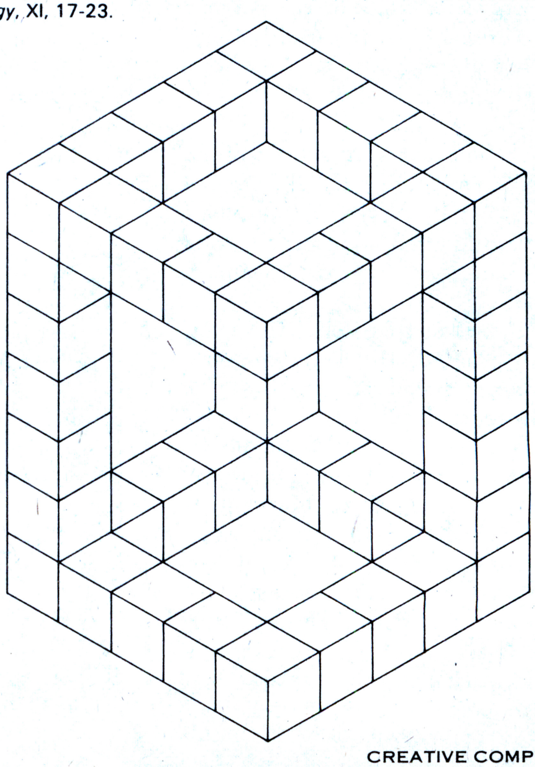
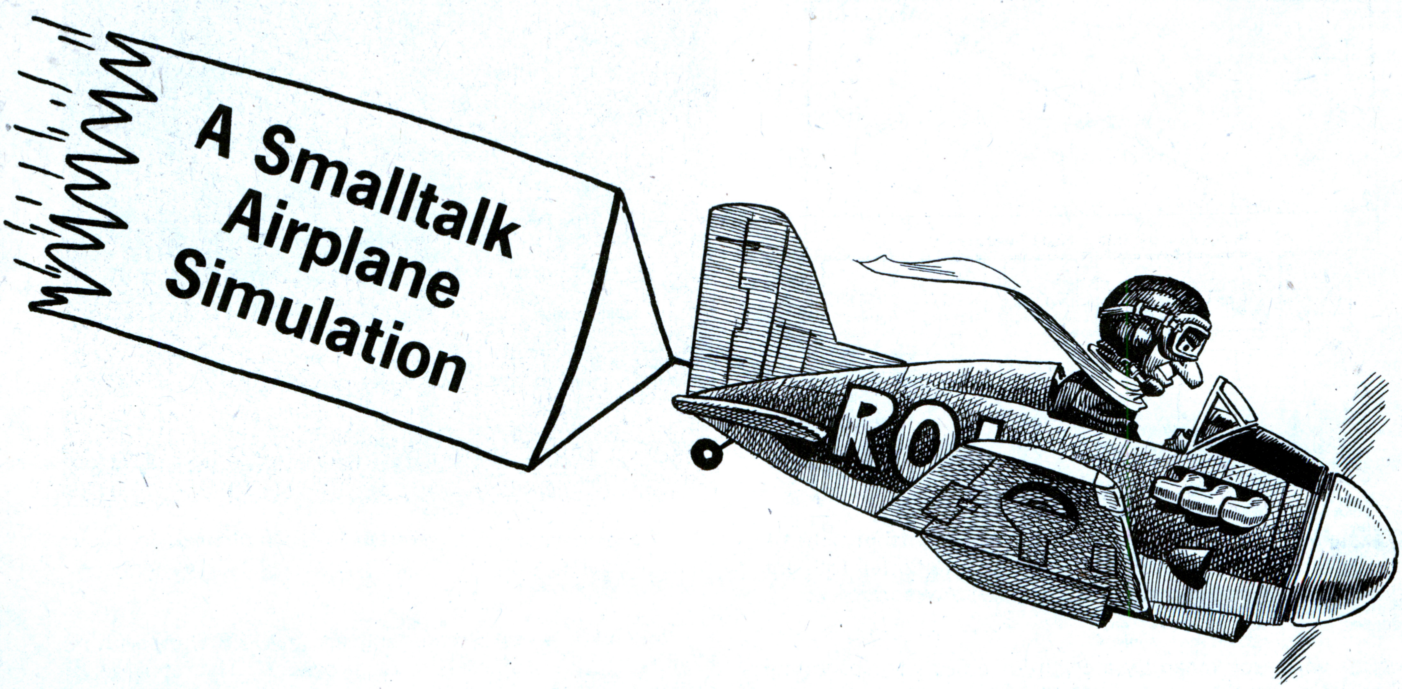


SAMPLE RUN

```
.EXECUTE PROOFS.SNO
---WHAT IS 'GIVEN'?
M-SEGMENT AC = M-SEGMENT AD.
---WHAT ELSE IS 'GIVEN'?
SEGMENT BC CONGRUENT SEGMENTBX\
---WHAT ELSE IS 'GIVEN'?
SEGMENT BC CONGRUENT SEGMENT BX.
---WHAT ELSE IS 'GIVEN'?
SEGMENT BD CONGRUENT SEGMENT BX.
---WHAT ELSE IS 'GIVEN'?
TRIANGLE ABC CORRESPONDS TRIANGLE ABD.
---WHAT ELSE IS 'GIVEN'?
PROVE
---WHAT IS 'TO BE PROVED'?
M-ANGLE ACB = M-ANGLE ADB.

---------------------------------------------------------------------
GIVEN: 0. M-SEGMENT AC = M-SEGMENT AD.
       0. SEGMENT BC CONGRUENT SEGMENT BX.
       0. SEGMENT BD CONGRUENT SEGMENT BX.
       0. TRIANGLE ABC CORRESPONDS TRIANGLE ABD.
PROVE: 0. M-ANGLE ACB = M-ANGLE ADB.
---------------------------------------------------------------------
STATEMENTS:                         REASONS:
---------------------------------------------------------------------

---WHAT IS YOUR STATEMENT NUMBER 1 ?
SEGMENT AC CONGRUENT SEGMENT AD.
---WHAT IS YOUR REASON NUMBER 1 ?
GIVEN.
---INVALID STATEMENT.
---WHAT IS YOUR STATEMENT NUMBER 1 ?
M-SEGMENT AC = M-SEGMENT AD.
---WHAT IS YOUR REASON NUMBER 1 ?
GIVEN.

1. M-SEGMENT AC = M-SEGMENT AD.    ! 1. GIVEN (VALID).

---NEW CONCLUSIONS FROM THE ABOVE ARE:
SEGMENT AC CONGRUENT SEGMENT AD.
---WHAT IS YOUR STATEMENT NUMBER 2 ?

---NULL STRING WAS INPUT AND IGNORED.
---MAY BE DUE TO SENSITIVE KEYBOARD AT TERMINAL.
---WHAT IS YOUR STATEMENT NUMBER 2 ?
SEGMENT AC CONGRUENT SEGMENT AD.
---WHAT IS YOUR REASON NUMBER 2 ?
GIVEN.

2. SEGMENT AC CONGRUENT SEGMENT    ! 2. DEFINITION CONGRUENCE AND
   AD.                             !    STATEMENT 1. NOT 'GIVEN'
                                   !    (STUDENT ERROR).

---NEW CONCLUSIONS FROM THE ABOVE ARE:
SEGMENT AD CONGRUENT SEGMENT AC.
M-SEGMENT AC = M-SEGMENT AD.
---WHAT IS YOUR STATEMENT NUMBER 3 ?
SEGMENT BC CONGRUENT SEGMENT BX.
---WHAT IS YOUR REASON NUMBER 3 ?
GIVEN.

3. SEGMENT BC CONGRUENT SEGMENT    ! 3. GIVEN (VALID).
   BX.                             !

---NEW CONCLUSIONS FROM THE ABOVE ARE:
SEGMENT BX CONGRUENT SEGMENT BC.
M-SEGMENT BC = M-SEGMENT BX.
---WHAT IS YOUR STATEMENT NUMBER 4 ?
SEGMENT BD CONGRUENT SEGMENT BX.
---WHAT IS YOUR REASON NUMBER 4 ?
GIVEN.

4. SEGMENT BD CONGRUENT SEGMENT    ! 4. GIVEN (VALID).
   BX.                             !

---NEW CONCLUSIONS FROM THE ABOVE ARE:
SEGMENT BX CONGRUENT SEGMENT BD.
M-SEGMENT BD = M-SEGMENT BX.---WHAT IS YOUR STATEMENT NUMBER 5 ?

---NULL STRING WAS INPUT AND IGNORED.
---MAY BE DUE TO SENSITIVE KEYBOARD AT TERMINAL.
---WHAT IS YOUR STATEMENT NUMBER 5 ?
SEGMENT BX CONGRUENT SEGMENT BD.
---WHAT IS YOUR REASON NUMBER 5 ?
DON'T KNOW

5. SEGMENT BX CONGRUENT SEGMENT    ! 5. SYMMETRIC PROPERTY CONGRUENCE
   BD.                             !    AND STATEMENT 4. IS VALID
                                   !    (STUDENT ERROR).

---NEW CONCLUSIONS FROM THE ABOVE ARE:
SEGMENT BD CONGRUENT SEGMENT BX.
SEGMENT BC CONGRUENT SEGMENT BD.
SEGMENT BD CONGRUENT SEGMENT BD.
M-SEGMENT BX = M-SEGMENT BD.
---WHAT IS YOUR STATEMENT NUMBER 6 ?
SEGMENT B\
---WHAT IS YOUR STATEMENT NUMBER 6 ?
TOTAL
SEGMENT AC CONGRUENT SEGMENT AD.
SEGMENT AD CONGRUENT SEGMENT AC.
M-SEGMENT AC = M-SEGMENT AD.
SEGMENT BX CONGRUENT SEGMENT BC.
M-SEGMENT BC = M-SEGMENT BX.
SEGMENT BX CONGRUENT SEGMENT BD.
M-SEGMENT BD = M-SEGMENT BX.
SEGMENT BD CONGRUENT SEGMENT BX.
SEGMENT BC CONGRUENT SEGMENT BD.
SEGMENT BD CONGRUENT SEGMENT BD.
M-SEGMENT BX = M-SEGMENT BD.
---WHAT IS YOUR STATEMENT NUMBER 6 ?
REVIEW
1. M-SEGMENT AC = M-SEGMENT AD.
2. SEGMENT AC CONGRUENT SEGMENT AD.
3. SEGMENT BC CONGRUENT SEGMENT BX.
4. SEGMENT BD CONGRUENT SEGMENT BX.
5. SEGMENT BX CONGRUENT SEGMENT BD.
```

```
---WHAT IS YOUR STATEMENT NUMBER 6 ?
SEGMENT BC CONGRUENT SEGMENT BD.
---WHAT IS YOUR REASON NUMBER 6 ?
DON'T KNOW

6. SEGMENT BC CONGRUENT SEGMENT    ! 6. TRANSITIVE PROPERTY CONGRUENCE
   BD.                             !    AND STATEMENTS 3,5. IS VALID
                                   !    (STUDENT ERROR).

---NEW CONCLUSIONS FROM THE ABOVE ARE:
SEGMENT BD CONGRUENT SEGMENT BC.
M-SEGMENT BC = M-SEGMENT BD.
---WHAT IS YOUR STATEMENT NUMBER 7 ?
TRIANGLE ABC CORRESPONDS TRIANGLE ABD.
---WHAT IS YOUR REASON NUMBER 7 ?
GIVEN.

7. TRIANGLE ABC CORRESPONDS        ! 7. GIVEN (VALID).
   TRIANGLE ABD.                   !

---NEW CONCLUSIONS FROM THE ABOVE ARE:
---NONE.
---WHAT IS YOUR STATEMENT NUMBER 8 ?
TRIANGLE ABC CONGRUENT TRIANGLE ABD.
---WHAT IS YOUR REASON NUMBER 8 ?
GIVEN.
---INVALID STATEMENT.
---WHAT IS YOUR STATEMENT NUMBER 8 ?
SEGMENT AB CONGRUENT SEGMENT AB.
---WHAT IS YOUR REASON NUMBER 8 ?
REFLEXIVE PROPERTY.

8. SEGMENT AB CONGRUENT SEGMENT    ! 8. REFLEXIVE PROPERTY CONGRUENCE
   AB.                             !    AND STATEMENT 8. IS VALID
                                   !    (STUDENT ERROR).

---NEW CONCLUSIONS FROM THE ABOVE ARE:
TRIANGLE ABC CONGRUENT TRIANGLE ABD.
M-SEGMENT AB = M-SEGMENT AB.
---WHAT IS YOUR STATEMENT NUMBER 9 ?
TRIANGLE ABC CONGRUENT TRIANGLE ABD.
---WHAT IS YOUR REASON NUMBER 9 ?
DON'T KNOW.

9. TRIANGLE ABC CONGRUENT          ! 9. SIDE SIDE SIDE AND STATEMENTS
   TRIANGLE ABD.                   !    2,6,7,8. IS VALID (STUDENT
                                   !    ERROR).

---NEW CONCLUSIONS FROM THE ABOVE ARE:
TRIANGLE ABD CONGRUENT TRIANGLE ABC.
M-TRIANGLE ABC = M-TRIANGLE ABD.
SEGMENT AB CONGRUENT SEGMENT AB.
SEGMENT BC CONGRUENT SEGMENT BD.
SEGMENT AC CONGRUENT SEGMENT AD.
ANGLE ABC CONGRUENT ANGLE ABD.
ANGLE BAC CONGRUENT ANGLE BAD.
ANGLE ACB CONGRUENT ANGLE ADB.
---WHAT IS YOUR STATEMENT NUMBER 10 ?
ANGLE ACB CONGRUENT S\
---WHAT IS YOUR STATEMENT NUMBER 10 ?
ANGLE ACB CONGRUENT ANGLE ADB.
---WHAT IS YOUR REASON NUMBER 10 ?
DEFINITION CONGRUENT TRIANGLE\S AND STATEMENT 9.

10. ANGLE ACB CONGRUENT ANGLE ADB. ! 10. DEFINITION CONGRUENT
                                   !     TRIANGLES AND STATEMENT 9. IS
                                   !     VALID (STUDENT ERROR).

---NEW CONCLUSIONS FROM THE ABOVE ARE:
ANGLE ADB CONGRUENT ANGLE ACB.
M-ANGLE ACB = M-ANGLE ADB.
---WHAT IS YOUR STATEMENT NUMBER 11 ?
M-ANGLE ACB = M-ANGLE ADB.
---WHAT IS YOUR REASON NUMBER 11 ?
DEFINITION CONGRUENCE AND STATEMENT 10.

---------------------------------------------------------------------
GIVEN: 0. M-SEGMENT AC = M-SEGMENT AD.
       0. SEGMENT BC CONGRUENT SEGMENT BX.
       0. SEGMENT BD CONGRUENT SEGMENT BX.
       0. TRIANGLE ABC CORRESPONDS TRIANGLE ABD.
PROVE: 0. M-ANGLE ACB = M-ANGLE ADB.
---------------------------------------------------------------------
STATEMENTS:                         REASONS:
---------------------------------------------------------------------
1. M-SEGMENT AC = M-SEGMENT AD.    ! 1. GIVEN (VALID).
2. SEGMENT AC CONGRUENT SEGMENT    ! 2. DEFINITION CONGRUENCE AND
   AD.                             !    STATEMENT 1. NOT 'GIVEN'
                                   !    (STUDENT ERROR).
3. SEGMENT BC CONGRUENT SEGMENT    ! 3. GIVEN (VALID).
   BX.                             !
4. SEGMENT BD CONGRUENT SEGMENT    ! 4. GIVEN (VALID).
   BX.                             !
5. SEGMENT BX CONGRUENT SEGMENT    ! 5. SYMMETRIC PROPERTY CONGRUENCE
   BD.                             !    AND STATEMENT 4. IS VALID
                                   !    (STUDENT ERROR).
6. SEGMENT BC CONGRUENT SEGMENT    ! 6. TRANSITIVE PROPERTY CONGRUENCE
   BD.                             !    AND STATEMENTS 3,5. IS VALID
                                   !    (STUDENT ERROR).
7. TRIANGLE ABC CORRESPONDS        ! 7. GIVEN (VALID).
   TRIANGLE ABD.                   !
8. SEGMENT AB CONGRUENT SEGMENT    ! 8. REFLEXIVE PROPERTY CONGRUENCE
   AB.                             !    AND STATEMENT 8. IS VALID
                                   !    (STUDENT ERROR).
9. TRIANGLE ABC CONGRUENT          ! 9. SIDE SIDE SIDE AND STATEMENTS
   TRIANGLE ABD.                   !    2,6,7,8. IS VALID (STUDENT
                                   !    ERROR).
10. ANGLE ACB CONGRUENT ANGLE ADB. ! 10. DEFINITION CONGRUENT
                                   !     TRIANGLES AND STATEMENT 9. IS
                                   !     VALID (STUDENT ERROR).
11. M-ANGLE ACB = M-ANGLE ADB.     ! 11. DEFINITION CONGRUENCE AND
                                   !     STATEMENT 10. (VALID).
---------------------------------------------------------------------
2 INVALID STATEMENTS, 6 ERRONEOUS REASONS. ---Q.E.D.
---------------------------------------------------------------------

EXIT
```

A Smalltalk Airplane Simulation



by Bruce Horn

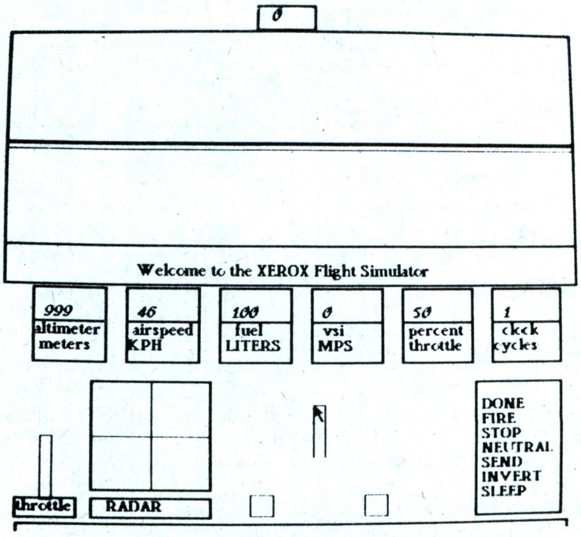
My name is Bruce Horn, and I am a junior at Gunn Senior High School in Palo Alto, California. I have been programming for about 3 years, mostly in Basic or Algol on Hewlett-Packard systems, such as the HP-3000. I would usually write simulations of other languages in Basic, or some type of mathematical program such as a program to plot equations.

At the end of the first semester, one of the math teachers asked me if I would like to get some Exploratory Experience credit (a program for work experience without pay) for working with computers at Xerox. I remember visiting the Xerox Palo Alto Research Center (PARC) one time before, so I decided that it would be a great experience. Since then, I have been working on one major project: an airplane simulator.

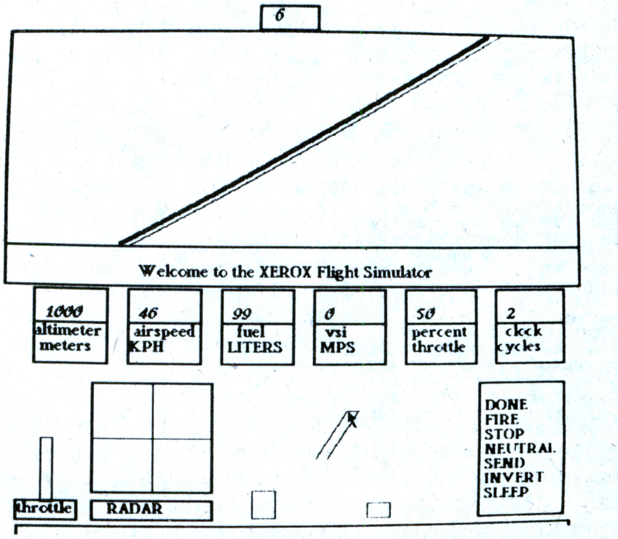
The computer that we use at PARC is a single user computer with a disc drive, keyboard, a graphics display, a five finger keyset and a pointer called a mouse. Since it is not timeshared, the machine responds quickly. It uses a totally new language called Smalltalk.

My idea of an airplane simulation is a program that would totally imitate the movements and attitude of an actual airplane, including the instruments used and the actual position of the horizon that you see. An ideal simulation on a computer would have to be realistic enough to be interesting. This would involve realistic output so that you could really see what is going on, and convenient input (stick, throttle, rudder) so that you can control the simulated airplane easily.

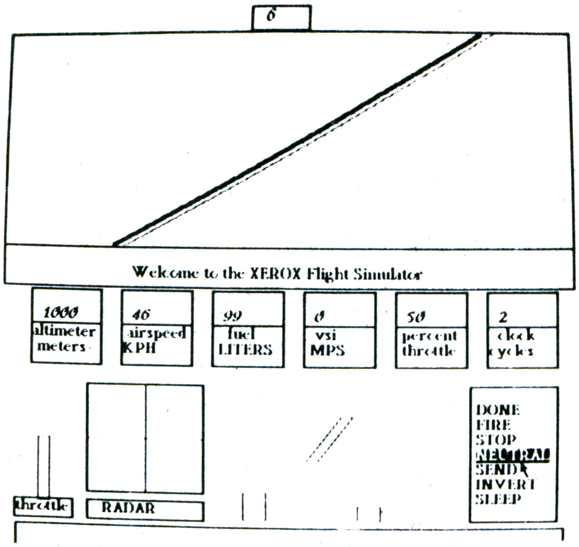
The basic idea behind Smalltalk is the concept of *classes* and *instances*. Programming in Smalltalk means that you


0
Welcome to the XEROX Flight Simulator
999
altimeter meters
46
airspeed KPH
100
fuel LITERS
0
vsi MPS
50
percent throttle
1
clock cycles
DONE
FIRE
STOP
NEUTRAL
SEND
INVERT
SLEEP
throttle
RADAR

1. Photograph of the display screen showing the airplane flying straight and level (with no bank).


6
Welcome to the XEROX Flight Simulator
1000
altimeter meters
46
airspeed KPH
99
fuel LITERS
0
vsi MPS
50
percent throttle
2
clock cycles
DONE
FIRE
STOP
NEUTRAL
SEND
INVERT
SLEEP
throttle
RADAR

2. Airplane is in a turn — banking and depressing the right rudder pedal.



Welcome to the XEROX Flight Simulator

1000 altimeter meters
46 airspeed KPH
99 fuel LITERS
0 vsi MPS
50 percent throttle
2 clock cycles

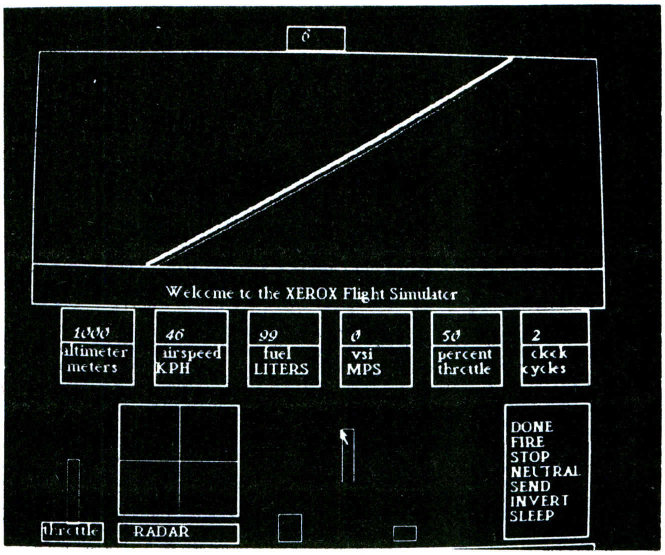
3. Selecting a command from the menu (bottom right of screen) — command word is inverted when pointed to. I am pointing at 'neutral,' a command to reset any control.

define what you mean by a group of objects by specifying the action each member of the group can take and describing properties that distinguish each member of the group.

Since there are many different instruments in an airplane, but they do nearly the same thing, I defined one class called *instrument* and created instances of that class for the different types of instruments. Each *instrument* is totally individual, but still retains the characteristics of the class. For example, each has its own location on the screen, a label for the instrument, and a value to display. Each *instrument* understands certain messages. Each does the same thing when it receives that particular message, but each instrument can be controlled individually. Each instance is different from another instance in the sense that each has different characteristics. However, each instance of the class called *instrument* has the same general form. A common example is the class of human beings. Every person is a human being, but each person may have different hair color, height, and weight.

The airplane simulator uses the mouse, keyset, and the keyboard together to send messages to the airplane to control its instruments. The mouse controls the position of the stick for pitch and roll, and it is used to select items from a menu of commands. A menu is a list of commands that can be executed by pointing at the command word with the mouse and pushing a button (Picture number 3). The keyset controls the setting of the rudder pedals and throttle, and uses different combinations of the five keys to control other operations in the simulator. At this time, the user sets the controls and requests a display of the state of the airplane with these control settings.

Later, I will have the airplane continually change state. Now that I have created the class *airplane* (the set of instruments and their display), I can create many instances, each running on a different computer. I hope to change the program so that other computers in the room can communicate with each other for a dogfight situation, complete with missiles and a working radar. The ultimate version of the simulator will have a more insteresting horizon that will change with the heading of the airplane (i.e., a total 360 degree panorama can be seen, including mountains and rivers) complete with perspective so that the actual position of the airplane relative to objects is more apparent.

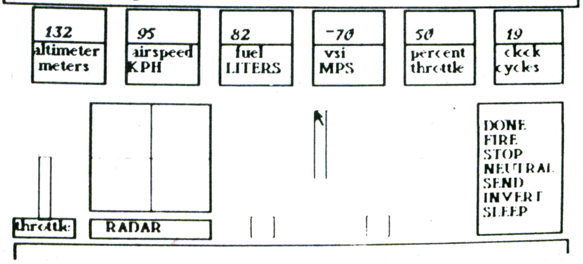


Welcome to the XEROX Flight Simulator

1000 altimeter meters
46 airspeed KPH
99 fuel LITERS
0 vsi MPS
50 percent throttle
2 clock cycles

4. The whole screen is inverted — black changes to white and vice versa.

Smalltalk is a very easy language to work with, with no limits to the complexity of programs. The concept of *classes* and *instances* is a very powerful idea and can be used very easily to simplify very complex problems. This is just not possible in Basic, no matter how advanced the version is. Therefore, a normal Basic program will probably look more complex than the same program written in Smalltalk, and, therefore, most likely harder to understand. The line-by-line execution of Basic is harder to understand, with the problem of if . . .thens and gotos interrupting the flow of the program. If this simulation was written in Basic, just for the instruments there would have to be vectors storing the values of the instruments and their labels, since all variables are local in Basic, and any part of the program that would access the instrument's data would have to know which vector and what element of the vector. In Smalltalk, only the class would have to know the explicit details of where all the data was. By using nesting and different levels in the program, Smalltalk eliminates the problem of having to jump around in the program because of a conditional statement or goto. Overall, I think that Smalltalk is easier, more efficient, and more interesting to use than Basic.



Danger...Danger...Altitude is 132 meters.

132 altimeter meters
95 airspeed KPH
82 fuel LITERS
-70 vsi MPS
50 percent throttle
19 clock cycles

5. Just before a crash. You can't see the horizon because the airplane is facing the ground.

Problems for Creative Computing . . . .

Seeing is Believing but Simulating is Convincing

by Walter Koetke, Lexington High School

Simulation represents one of the more promising areas in which the computer can be used to provide pertinent data on the options facing our society. Many computer related texts, however, pursue the subject no further than Buffon's needle, playing craps or dealing cards. While these are indeed valid examples of simulation, they are not sufficient because: they do not clearly demonstrate a potential connection between simulation results and human decision making; they seem to associate simulation with theoretical problems of mathematics as opposed to real problems of society; and they are too simple to give a feeling for the true complexity of societal simulations. More elaborate simulations are available (such as the variety of material from the Huntington Project), but these are intended for students to execute rather than write. The following two problems are neither outstanding problems of society nor outstanding problems of mathematics. They are offered because they provide the student with the opportunity to write simulations that go just a little further than the standard examples.

Problem 1: Horse Ranch. Suppose you are a rancher and own 200 horses. All of your stock is healthy, and that's very important because you expect a buyer to arrive unannounced sometime in the next 10 days. The buyer is looking for 160 healthy horses. You know from experience that if he finds fewer than 160 healthy animals, he won't buy any at all. Clearly your finances could not absorb the complete loss of the entire sale.

Just as you're ready to celebrate the pending sale, you learn that one of your horses has "day cough", a terrible sounding disease of short duration. Day cough lasts exactly one day and immunity to re-exposure results. You know that each sick horse will contact five other horses each day, and each contact has 0.6 chance of transmitting the sickness if the contacted horse is healthy and not immune. Although your situation appears bleak, do you really have such a serious problem? Which of the following three alternatives is your best course of action and why is it best?

a) Stop worrying. There's really very little chance that fewer than 160 horses will be healthy during the next 10 days.

b) Solicit the expensive support of modern medical science. "Cough shots" are available that are supposed to provide instant immunity when given to a healthy horse. However, only 13 horses per day can be innoculated by the local veterinarian, and neither he nor you can tell a healthy horse from a horse already immune. Thus you may innoculate an already immune horse. The only problem in doing this is that one of the cough shots is wasted. Actually, the cough shots have a 90% chance of providing instant immunity and a 10% chance of instantly giving day cough to a healthy horse. For all his expertise and advice, the veterinarian will charge you one healthy horse for each day of service he provides.

c) By calling right away, you can probably convince the buyer to delay his unannounced visit for 10 days. He will still come unannounced, but during the period 10 to 20 days from now rather than during the next 10 days.

Problem 2: Fish Pond. As part of a conservation and ecology project, a group of biology students has designed the following controlled experiment: A small pond is polluted with several common types of waste material. Exactly 100 male fish are then introduced to the previously fish free pond. Each day the students carefully net exactly 10 fish. All 10 fish are caught simultaneously and at the same time each day. The netted fish are examined for signs of gill disease, their tails dyed, and they are returned to the pond. The dye used is harmless and completely disappears after 13 full days in the water. If a netted fish is already dyed, it is dyed again so that it too will remain dyed for the next 13 days. The experiment continues until each of the fish netted on any one day all have dye on their tails.

How many days should the students allow to permit "a reasonable chance" for successful completion of the experiment?

A complete solution to this problem, as in many problems of society for which computer simulations might be useful, requires clarification of some human values. The definition of "a reasonable chance" is a personal one, and as such it is based on a wide variety of factors. Discussing the point alone makes this a very worthwhile problem in a classroom setting.

A closely related simulation problem can be described by not stating the number of fish in the pond, but instead specifying the number of days that pass before the 10 fish netted all have dye on their tails. The question then becomes "How many fish were originally in the pond?" For instance, if the experiment described was completed in 32 days, how many fish were originally placed in the pond?

Problem 3: Superspy. This one is included just for fun. The problem is really another disguise of the two dimensional random walk.

Each night IBF, the superspy, leaves his daytime refuge and emerges from a secret manhole cover in the center of a city. Being an exceptionally tricky spy, IBF is likely to sneak forward, backward, left or right at every intersection. If IBF happens to accidentally stray 8 blocks from the manhole (in any direction) he is captured by the arch enemies of society, the TUVEFOUT. If IBF happens to return to his manhole, he is safe for another night. What is the probability that IBF will return safely and thus complete a successful mission? What is the average number of blocks traveled during a mission?

Summary of the ACM Sixth U.S. Computer Chess Championship

by M. M. Newborn
McGill University, Montreal, Canada

Playing stronger chess than ever before on CDC's superfast CYBER 175, CHESS 4.4, the chess program of David Slate and Larry Atkin captured the ACM's Sixth U.S. Computer Chess Championship in Minneapolis at the ACM's Annual Conference on October 19-21, 1975. CHESS 4.4 defeated all four opponents in capturing its fifth of the ACM's six tournaments. TREEFROG, the work of Ron Hansen, Gary Calnek, and Russell Crook of the University of Waterloo and winner in 1975, lost only to CHESS 4.4 in the final round and finished in second place. It was TREEFROG (under the name RIBBIT) that dethroned Slate Atkin's program last year. Twelve teams participated in the four round Swiss style tournament.

In addition to the tournament, David Levy, International Master from England and the tournament director, played a simultaneous exhibition on Sunday evening against the programs. SORTIE passed up the exhibition; Slate and Atkin's program played two boards running on Northwestern University's CDC 6400 computer in one game and on a CDC CYBER 175 in the other. Levy won ten games, drew two, and lost none; CHESS 4.4, running on the CYBER 175 and TREEFROG, running on a Honeywell 6080 drew with Levy. Against CHESS 4.4, the game ended with Levy having a Pawn on the seventh rank but down a Knight and probably lost against best play by his opponent (Fig. 1). In his game against TREEFROG, Levy left a rook en prise on the 50th move and was fortunate to gain a draw when TREEFROG was unable to force a win with a Rook and Bishop to Levy's Bishop of opposite color. (Fig. 2). In the exhibition the computers played at a rate of 40 moves in two hours.

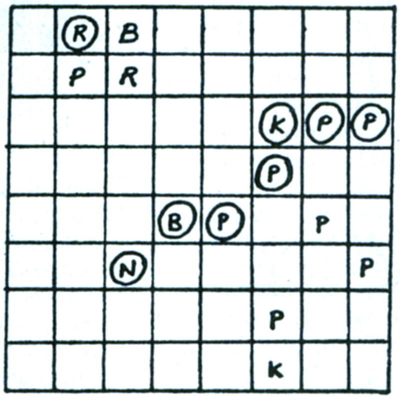


Fig. 1. Position at end of Levy (White) vs CHESS 4.0 (Black) White to move.

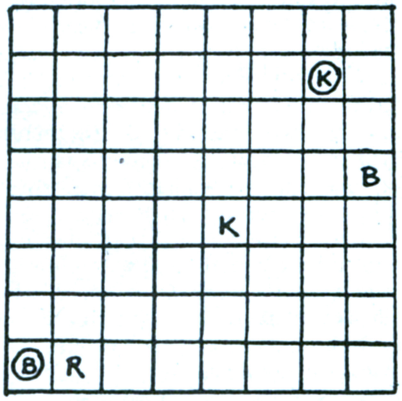


Fig. 2. Position at end of TREEFROG (White) vs Levy (Black) Black to move.

*Black pieces are circled

David Slate, programmer of CHESS 4.0, winner at ACM-76.

"The minute you say that a thing cannot be done, you are through with that thing. And no matter how much you know — even if you are an expert — if you say it can't be done, you are all through. And someone knowing nothing about it, but thinking it can be done, now is a better man for the job than you."

Harry Myers

Computer Chess by M. NEWBORN

A Volume in the ACM MONOGRAPH Series

Here is perhaps the first detailed survey of computer chess—one that brings together all the important games in which computers have played. It presents thirty-eight games between computer and computer or between computer and man, including games from the first United States Computer Chess Championships and games played recently by Soviet computers. And it's easy to read.

COMPUTER CHESS will be fascinating reading for the computer scientist, members of the general scientific community, and the chess buff. Moreover, the book provides sufficient information to allow someone interested in creating a chess program of his own to get a start in that direction.

1975, 200 pp., $15.00/£7.20

A 20% discount is available to members of the ACM for orders directed to Academic Press. Members must include their active membership number.

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Sequences

Becky Jessen, Senior
Sylmar High School Sylmar, California

Shortly before World War II, chain letters became the rage. If you receive one, typically you'll find five names in the letter. You will be asked to send an amount of money to the person whose name is at the top of the list. You then cross this name off the list, add your name to the bottom and send five copies to friends. Suppose the amount is $1.00 and let's ignore postage, which is up a bit, since the 1930's. How could you make out?

You send out 5 letters with your name at the bottom. If your friends follow through, together they'll send out 5^2 or 25 letters, with your name fourth. If their friends continue, 5^3 or 125 letters will be sent with your name third.

$$5^1, 5^2, 5^3, 5^4, 5^5$$
$$5, 25, 125, 625, 3125$$

If everyone followed through, you'd receive $3,125. Do you think this idea would work? It did in the 1930's for a few, but it's illegal, now. Can you see the problems? If it were possible to do, how many names would need to be on the list for you to collect at least a million dollars? How about a billion dollars?

This kind of sequence, 1, 5, 25, , . . . in which each term is a constant multiple of the previous term, is called a geometric sequence. The simplest of these is
1, 2, 4, 8, 16, 32, . . .
Here, the constant multiplier is 2.

An ancient legend has it, that a man given his choice of anything he desired, by a very rich king, asked for one grain of wheat on the first square of a chessboard, 2 on the second, 4 on the third, and so forth. How many grains of wheat would he have received, had his request been granted? (Rumor has it that the king found it better to take off a head, rather than provide the grain.) Find an estimate for the size of wheat and the number of grains that can be stored in a cubic foot. Then determine the amount of ground that could be covered a foot high with the amount of wheat requested.

A more recent question, based on this same sequence, is, "Which would you rather be paid; $100. per day or 1¢ the first day, 2¢ the second, 4¢ the third, and so forth, for 30 days?" Which one would you choose? Would your choice be the same if the daily rate was $1000. per day?

You had two parents, each of them had two parents (you had four grandparents), and so forth. At some point, the number of your ancestors would exceed the total world population today. In what past year, would your original ancestors have been born, assuming this ideal model? How many people were on the earth in the year you have found? What do these results mean?

An arithmetic sequence grows very slowly. The sequence of even numbers, for example, is
2, 4, 6, 8, 10, 12, . . .
The geometric sequence grows much faster.
1, 2, 4, 8, 16, 32, . . .
Here is another sequence, called the Fibonacci sequence.
1, 1, 2, 3, 5, 8, . . .

Each term is the sum of the two preceding terms. Which of the three sequences grows the fastest? How does the Fibonacci sequence compare to the arithmetic sequence? Is there an arithmetic sequence that will grow faster than the Fibonacci?

The Fibonacci sequence is of great interest to mathematicians. Apparently there is no end to the neat things to be discovered about it. For example, 1 + 1 + 2 + 3 + 5 + 8 = 20. What is the eighth term of the sequence? Compare the sum of the first 20 terms with the 22nd term. Will this relationship always hold true?

Here is a pattern.
$1^2 + 1^2 = 1 \cdot 2$
$1^2 + 1^2 + 2^2 = 2 \cdot 3$
$1^2 + 1^2 + 2^2 + 3^2 = 3 \cdot 5$
Do you see the pattern? Do you think it continues? How far?

The Greeks were fascinated by "The Golden Ratio". Pages of books and shapes of pictures tend to have sides whose measures have approximately this ratio. Many artists, through trial and error, have been led to this ratio, while searching for ways to present pleasing patterns and correct projections. Any consecutive terms of the Fibonacci sequence, approximate this ratio. And the accuracy increases the larger the terms used. Have a computer list the sequence of ratios, comparing consecutive terms of this sequence. See if you can find a good approximation for the golden ratio, perhaps five or six decimal places.

Sequences continue to be popular with mathematicians, amateur and professional alike. In fact, amateur mathematicians have made some startling discoveries in this area. A computer gives us the power to examine large numbers of terms and allows us to consider things we never could do, if all we had was paper and pencil.

References to consider:

- Andree, Richard, *Computer Programming and Related Mathematics,* John Wiley & Sons, Inc., New York, N. Y., 1967.
- Jacobs, Harold R., *Mathematics: A Human Endeavor,* W. H. Freeman & Co., San Francisco, Ca., 1970.
- "The Fibonacci Quarterly", St. Mary's College, California.

Puzzles and Problems For Fun

THE KING'S SEAL

The King of Dnal Retupmoc, a tiny kingdom lying between India and Laos, has a serious problem. His computer, through a malfunction, destroyed a very important program which produces the King's seal. To be official the seal must be printed by the magic terminal with a special printing device. The seal must look as follows:

```
       X
      XXX
     XXXXX
    XXXXXXX
   XXXXXXXXX
  XXXXXXXXXXX
 XXXXXXXXXXXXX
XXXXXXXXXXXXXXX
 XXXXXXXXXXXXX
  XXXXXXXXXXX
   XXXXXXXXX
    XXXXXXX
     XXXXX
      XXX
       X
```

To avoid unauthorized use of his terminal in producing the seal the King's computer is designed to reject any program which uses the words "Tab" and "Print" more than once and the computer operates only in the BASIC language.

Your mission, should you accept, is to fly to Dnal Retupmoc and re-program the King's computer. (This paper will self-destruct upon contact with a wastebasket.)

MACUG Newsletter

BUT NO INCEST

There are three families each with two sons and two daughters. In how many ways can all these young people be married?

MACUG Newsletter

MAX MACHINE

Given a machine which can do addition, subtraction, multiplication, division, and find absolute values, show how to program it to find max (x,y); that is, if two numbers are fed in, the output should be the larger of the two. No "IF" statements allowed.

MACUG Newsletter

Thinkers' Corner

by Layman E. Allen © 1975

SET THEORY PUZZLES

How many of the problems (a) through (f) below can you solve by forming an expression that will name the number of cards in the universe that is listed as the GOAL? (Suppose that each letter and symbol below is imprinted on a disc.)

The expression must use:

(1) all of the discs in the REQUIRED column
(2) as many of the discs in PERMITTED as you wish, and
(3) exactly one of the discs in RESOURCES

Universe of Cards	1	2	3	4	5	6
	A B D	B C	A B C	B	B D	C

Examples:

The expression A names 2 cards (1,3).

The expression A' (complement) names 4 cards (2,4,5,6).

The expression B ∩ C (intersection) names 2 cards (2,3).

The expression B ∪ C (union) names 6 cards (1,2,3,4,5,6).

The expression C-B (difference) names 1 card (6).

Problem	GOAL	REQUIRED	PERMITTED	RESOURCES
(a)	4	∪	B C D -	A B C ∩ -
(b)	4	D	B D ∪ ∩	A B C D -
(c)	1	A ∪	A B C ∪	A B C D ∪
(d)	6	C '	A B D	A B C D ∪ ∩
(e)	1	D	B D ∩ '	B D ∩ '
(f)	1	C ∩	B C - '	B C D ∩ -

If you enjoy this kind of puzzle, you may like playing ON-SETS: The Game of Set Theory. Free information about this and other instructional games is available upon request from THE FOUNDATION FOR THE ENHANCEMENT OF HUMAN INTELLIGENCE, 1900-S Packard Rd., Ann Arbor, MI 48104.

Some Suggested Answers (frequently there are others):

(a) A ∪ C (b) D' or D ∪ (B ∩ C) (c) Impossible
(d) (C ∩ D)' (e) B' ∩ D'
(f) D' ∩ (B-C) or C'-(B ∩ D) or (C ∩ D)'-B or D' ∩ (C-B).

FREE THROWS

If a basketball player averages 7 out of 10 at the free throw line, what is the expected value of his score if he is allowed to shoot until he misses?

MACUG Newsletter

* * *

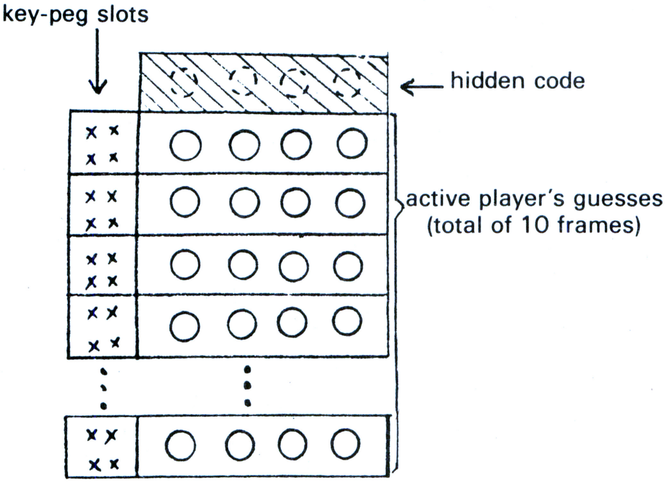
The *MACUG Newsletter* is edited by Joe Kmoch and Hank Kepner and is distributed to high schools who are members of the Milwaukee Area Computer Users Group.

MASTERMIND

by David G. Struble
University of Dayton

The original invention of Mastermind is credited to an amateur mathematician, Mordechai Meirovich, who first displayed it at the 1971 Nurenburg Toy Fair.* Rights to the game were bought by Invicta who had moderate success with the game for 2½ years until the Christmas season of 1975 when it was the most popular packaged game. Sales surpassed even the old standby, Monopoly.

In its most basic form, Mastermind consists of a plastic game board, a dozen or so pegs which can be grouped into six basic colors, and two groups of black and white key pegs (sometimes called "inference pegs".) The game board resembles the figure below.



The game is played by two people, whom we shall designate as the "active" player and the "passive" player. The first step before play actually commences is to have the passive player (in our case, the computer) choose a total of four colored pegs at random from any of the six basic color groups (duplicate colors allowed, of course.) He then conceals these colors from the active player by placing the four pegs in the "hidden code" portion of the game board. It is now up to the active player to determine, in ten moves or less, the exact color and location of each of the four pegs comprising the hidden code.

To aid the active player in determining the hidden code, the passive player must award the active player a number of key pegs (inference pegs) after each guess, according to the following scheme: for *each* peg in the active player's current guess which corresponds exactly (in color *and* position) to a peg in the hidden code, the passive person places one *black* peg in the key-peg square adjacent to the passive player's current guess frame. Placing of the key pegs within the square is arbitrary since the relative position of the key peg carries no meaning. Clearly, when four black pegs are obtained, the hidden code is broken.

Secondly, the passive player must place one *white* key peg in the current key-peg square for *each* peg in the active player's current guess which matches (in color, but *not* position) a peg in the hidden code. Keep in mind that once a color peg in the player's current guess has been awarded a key peg, its function in determining the remaining number of key pegs to award for the current guess is finished. For example, suppose the hidden code were:

R B Y G

corresponding to red, blue, yellow, green, and the active player's current guess were:

G B B P

corresponding to green, blue, blue and purple.

The passive player should subsequently award one black and one white key peg for the following reasons: the blue color peg in position 2 of the current guess matches exactly in color and position with the hidden code. Secondly, the green color peg in position 1 of the current guess matches the color of the peg in position 4 of the hidden code. But since the *location* of the green peg is not exact, only a white peg is awarded. The blue and purple pegs in positions 3 and 4, respectively, of the current guess do not match either the color or position of the remaining pegs in the hidden code (positions 1 and 3) and hence, no other key pegs are awarded.

The game proceeds in this manner until the hidden code is broken or all ten frames have been filled. As noted earlier, the computer will play the passive player in our computer version, generating a hidden code and awarding the black and white key pegs after each guess.

The program offers the user two options, QUIT and BOARD, which may be entered at any time *after* the first move. QUIT instructs the program that you are fed up with playing Mastermind for the time being and wish to terminate the session. BOARD instructs the program to print out a summary of the moves prior to the time that the BOARD command was issued, including the guesses and key pegs awarded for each frame. Some players find that an arrangement of frames such as that provided by BOARD is easier to visualize and subsequently analyze. Beginners will find it most useful.

The program as listed will run on a Univac 70/7 under VMOS or equivalent Univac series 70 machine.

One last item. Any suggestions on how to get the machine to play the active person?

---

*Ed. Note—

To anyone familiar with children's games, it is obvious that Mastermind is simply a commercial adaptation (using colors rather than numbers) of the game Bulls and Cows. This game, much more popular in England than the U.S. is not, to my knowledge, commercially packaged although it is available in a computer (BASIC) version. This is the game BULCOW by Geoff Wyvill which appeared in *101 BASIC Computer Games* ($7.50 from *Creative Computing* Library, 42 Pleasant St., Newburyport, MA 01950). Geoff's computer version is especially intriguing since it plays two games simultaneously, the active player in one and the passive player in the other.
—DHA.

MASTERMIND

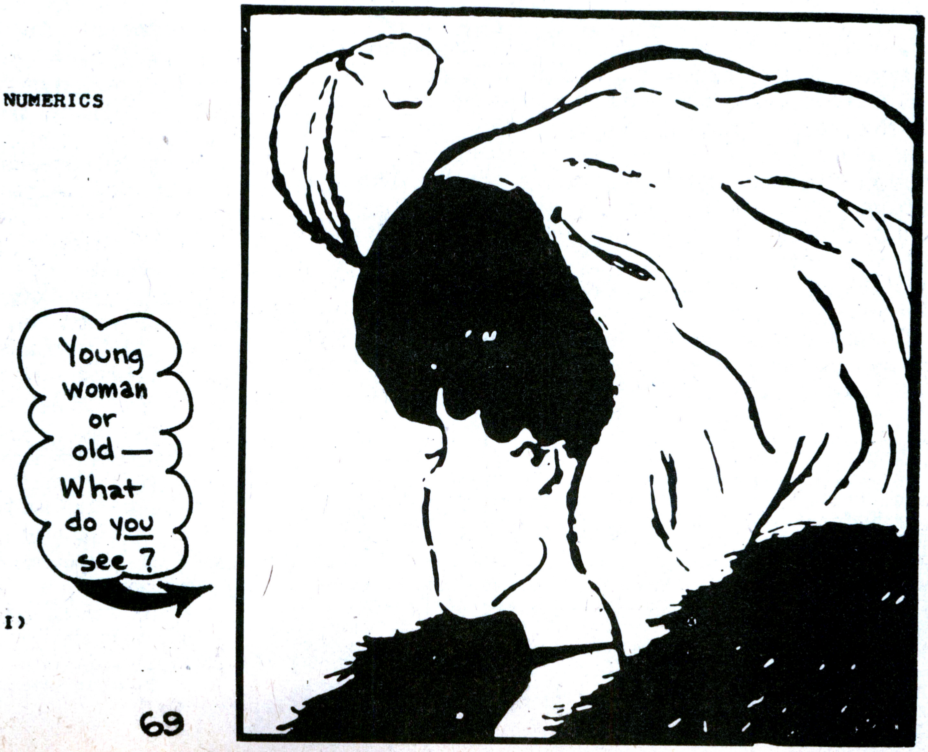
PROGRAM LISTING

```
100 PRINT
110 PRINT "THE GAME OF MASTERMIND"
120 PRINT
130 PRINT "COLOR CODES:"
140 PRINT "                R = RED      O = ORANGE       Y = YELLOW"
150 PRINT "                G = GREEN    B = BLUE         P = PURPLE"
160 PRINT
170 DIM B$(10),Y(10),Z(10)
180 C(0)=4
190 FOR N=1 TO 4
200 C(N)=INT(6*RND(-1)+1)
210 NEXT N
220 FOR N=1 TO 4
230 X=C(N)
240 GOSUB 730
250 C(N)=X
260 NEXT N
270 CHANGE C TO P$
280 FOR P=1 TO 10
290 PRINT
300 PRINT "MOVE NUMBER";P;
310 INPUT G$
320 IF G$="BOARD" THEN 910
330 IF G$="QUIT" THEN 440
340 B$(P)=G$
350 GOSUB 520
360 IF B=4 THEN 1010
370 GOSUB 600
380 PRINT B;" BLACK PEGS"
390 Y(P)=B
400 PRINT W;" WHITE PEGS"
410 Z(P)=W
420 NEXT P
430 PRINT "SORRY, YOU LOSE"
440 PRINT "CORRECT CODE WAS: ";P$
450 PRINT
460 PRINT "WANT TO PLAY AGAIN";
470 INPUT A$
480 IF A$="YES" THEN 190
490 PRINT
500 END
510 REM COMPUTE BLACK PEGS
520 CHANGE G$ TO G
530 B=0
540 FOR K=1 TO 4
550 IF G(K)<>C(K) THEN 570
560 B=B+1
570 NEXT K
580 RETURN
590 REM COMPUTE WHITE PEGS
600 CHANGE P$ TO R
610 W=0
620 FOR I=1 TO 4
630 FOR J=1 TO 4
640 IF G(I)<>R(J) THEN 680
650 W=W+1
660 R(J)=0
670 GOTO 690
680 NEXT J
690 NEXT I
700 W=W-B
710 RETURN
720 REM TRANSLATE COLOR CODES TO NUMERICS
730 IF X<>1 THEN 760
740 X=217
750 RETURN
760 IF X<>2 THEN 790
770 X=214
780 RETURN
790 IF X<>3 THEN 820
800 X=232
810 RETURN
820 IF X<>4 THEN 850
830 X=199
840 RETURN
850 IF X<>5 THEN 880
860 X=194
870 RETURN
880 X=215
890 RETURN
900 REM PRINT BOARD SUMMARY
910 V=P-1
920 PRINT USING 930
930 :GUESS   BLACKS   WHITES
940 PRINT USING 950
950 :-----   ------   ------
960 FOR I=1 TO V
970 PRINT USING 980,B$(I),Y(I),Z(I)
980 : ####      #        #
990 NEXT I
1000 GOTO 290
1010 PRINT "YOU WIN!"
1020 GOTO 450
*
```

SAMPLE RUN

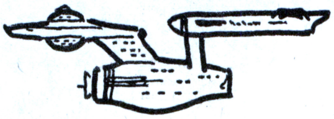
```
THE GAME ØF MASTERMIND

CØLØR CØDES:
                R = RED        Ø = ØRANGE       Y = YELLØW
                G = GREEN      B = BLUE         P = PURPLE

MØVE NUMBER 1   ?BRBR
  1   BLACK PEGS
  1   WHITE PEGS

MØVE NUMBER 2   ?PØPØ
  1   BLACK PEGS
  0   WHITE PEGS

MØVE NUMBER 3   ?YGYG
  1   BLACK PEGS
  0   WHITE PEGS

MØVE NUMBER 4   ?BRPY
  0   BLACK PEGS
  2   WHITE PEGS

MØVE NUMBER 5   ?RGBP
  2   BLACK PEGS
  1   WHITE PEGS

MØVE NUMBER 6   ?BØARD
GUESS    BLACKS    WHITES
-----    ------    ------
 BRBR       1         1
 PØPØ       1         0
 YGYG       1         0
 BRPY       0         2
 RGBP       2         1

MØVE NUMBER 6   ?RGØB
  1   BLACK PEGS
  3   WHITE PEGS

MØVE NUMBER 7    ?RØGB
  2   BLACK PEGS
  2   WHITE PEGS

MØVE NUMBER 8   ?RØBG
YØU WIN!

WANT TØ PLAY AGAIN?YES
```

One playing strategy is to guess pairs of all 6 colors on the first 3 moves. Is this the best strategy? Why or why not?


Young woman or old — What do you see ?

Another new game from Creative Computing . . . .

DEEPSPACE



Author: Unknown
Modified by: Bill Cotter, Pittsfield, Mass.
Language: BASIC (Honeywell 600/6000)

Description: DEEPSPCE is another version of a space battle. You become the commander of either a scout ship, cruiser, or battleship. You then pick the weapons, and planetary system to patrol, and it's time to do battle.

The closer you get to the enemy, the better your chance of destroying him. Unfortunately, his chance of destroying you also improves. If you get too close, you can damage yourself; when a vessel's damage rating reaches or exceeds 100, it's destroyed.

Suggestion: Change the time between reports—this will shorten the game by allowing you to get closer faster. Also, for a truly random game, Honeywell users should change RND(0) to RND(—1).

PROGRAM LISTING

```
100 PRINT
110 PRINT
120 PRINT "DEEPSPACE   ";DAT$
130 PRINT
140 PRINT
150 PRINT "THIS IS DEEPSPACE, A TACTICAL SIMULATION OF SHIP-TO SHIP"
160 PRINT "COMBAT IN DEEP SPACE."
170 PRINT "DO YOU WISH INSTRUCTIONS (YES OR NO)";\INPUT I$
180 IF I$="YES" THEN 200
190 GO TO 610
200 PRINT "YOU ARE ONE OF A GROUP OF CAPTAINS ASSIGNED TO PATROL A"
210 PRINT "SECTION OF YOUR STAR EMPIRE'S BORDER AGAINST HOSTILE"
220 PRINT "ALIENS. ALL YOUR ENCOUNTERS HERE WILL BE AGAINST HOSTILE"
230 PRINT "VESSELS. YOU WILL FIRST BE REQUIRED TO SELECT A VESSEL"
240 PRINT "FROM ONE OF THREE TYPES, EACH WITH ITS OWN CHARACTERISTICS:"
250 PRINT
260 PRINT "TYPE","SPEED","CARGO SPACE","PROTECTION"
270 PRINT "1 SCOUT","10X","16","1"
280 PRINT "2 CRUISER","4X","24","2"
290 PRINT "3 BATTLESHIP","2X","30","5"
300 PRINT
310 PRINT "SPEED IS GIVEN RELATIVE TO THE OTHER SHIPS."
320 PRINT "CARGO SPACE IS IN UNITS OF SPACE ABOARD SHIP WHICH CAN BE"
330 PRINT "FILLED WITH WEAPONS."
340 PRINT" PROTECTION IS THE RELATIVE STRENGTH OF THE SHIP'S ARMOR"
350 PRINT "AND FORCE FIELDS"
360 PRINT
370 PRINT "ONCE A SHIP HAS BEEN SELECTED, YOU WILL BE INSTRUCTED TO ARM"
380 PRINT "IT WITH WEAPONRY FROM THE FOLLOWING LIST:"
390 PRINT
400 PRINT "TYPE                                  CARGO SPACE    REL. STRENGTH"
410 PRINT "1 PHASER BANKS                          12              4"
420 PRINT "2 ANTI-MATTER MISSILE                   4              20"
430 PRINT "3 HYPERSPACE LANCE                      4              16"
440 PRINT "4 PHOTON TORPEDO                        2              10"
450 PRINT "5 HYPERON NEUTRALIZATION FIELD          20              6"
460 PRINT
470 PRINT"WEAPONS #1 & #5 CAN BE FIRED 100 TIMES EACH: ALL OTHERS CAN"
480 PRINT "BE FIRED ONCE FOR EACH ON BOARD."
490 PRINT "A TYPICAL LOAD FOR A CRUISER MIGHT CONSIST OF:"
500 PRINT "                 1-#1 PHASER BANK            =12"
510 PRINT "                 2-#3 HYPERSPACE LANCES      =8"
520 PRINT "                 2-#4 PHOTON TORPEDOES       =4"
530 PRINT "                                         ----------"
540 PRINT "                                       24 UNITS OF CARGO"
550 PRINT " A WORD OF CAUTION:FIRING HIGH YIELD WEAPONS AT CLOSE (< 100)"
560 PRINT "RANGE CAN BE DANGEROUS TO YOUR SHIP AND MINIMAL DAMAGE CAN"
570 PRINT "OCCUR AS FAR OUT AS 200 IN SOME CIRCUMSTANCES."
580 PRINT
590 PRINT "RANGE IS GIVEN IN THOUSANDS OF KILOMETERS."
```

LISTING continues on next page.

```
DEEPSPACE   05/29/75
```

SAMPLE RUN

```
THIS IS DEEPSPACE, A TACTICAL SIMULATION OF SHIP-TO SHIP
COMBAT IN DEEP SPACE.
DO YOU WISH INSTRUCTIONS (YES OR NO) ?NO
DO YOU WISH A MANEUVER CHART ?YES
                         **************

   MANEUVER CHART

 1      FIRE PHASERS
 2      FIRE ANTI-MATTER MISSILE
 3      FIRE HYPERSPACE LANCE
 4      FIRE PHOTON TORPEDO
 5      ACTIVATE HYPERON NEUTRALIZATION FIELD
 6      SELF-DESTRUCT
 7      CHANGE VELOCITY
 8      DISENGAGE
 9      PROCEED

YOU HAVE A CHOICE OF THREE SYSTEMS TO PATROL.
1 ORION
2 DENEB
3 ARCTURUS
SELECT A SYSTEM(1-3) ?3
WHICH SPACECRAFT WOULD YOU LIKE.(1-3) ?2
YOU HAVE    24 UNITS OF CARGO SPACE TO FILL WITH WEAPONRY.
CHOOSE A WEAPON AND THE AMOUNT YOU WISH. ?1,1
YOU HAVE    12 UNITS OF CARGO SPACE TO FILL WITH WEAPONRY.
CHOOSE A WEAPON AND THE AMOUNT YOU WISH. ?2,1
YOU HAVE     8 UNITS OF CARGO SPACE TO FILL WITH WEAPONRY.
CHOOSE A WEAPON AND THE AMOUNT YOU WISH. ?3,1
YOU HAVE     4 UNITS OF CARGO SPACE TO FILL WITH WEAPONRY.
CHOOSE A WEAPON AND THE AMOUNT YOU WISH. ?4,2

RANGE TO TARGET:   658.3301
RELATIVE VELOCITY:   3.154701
ACTION ?9

RANGE TO TARGET:   599.0996
RELATIVE VELOCITY:   3.154701
ACTION ?9

RANGE TO TARGET:   539.8691
RELATIVE VELOCITY:   3.154701
ACTION ?7
CHANGE TO BE EFFECTED ?2
CHANGE BEYOND MAXIMUM POSSIBLE
INCREASING TO MAXIMUM

RANGE TO TARGET:   460.1757
RELATIVE VELOCITY:    4
ACTION ?9
DAMAGE CONTROL REPORTS YOUR VESSEL DAMAGE AT:    5.329875

RANGE TO TARGET:   380.4822
RELATIVE VELOCITY:    4
ACTION ?1
SCANNERS REPORT ENEMY DAMAGE NOW:   1.260274
DAMAGE CONTROL REPORTS YOUR VESSEL DAMAGE AT:    0.74178

RANGE TO TARGET:   300.7888
RELATIVE VELOCITY:    4
ACTION ?2
SCANNERS REPORT ENEMY DAMAGE NOW:   40.81256
DAMAGE CONTROL REPORTS YOUR VESSEL DAMAGE AT:    15.35915

RANGE TO TARGET:   221.0953
RELATIVE VELOCITY:    4
ACTION ?1
SCANNERS REPORT ENEMY DAMAGE NOW:   43.63048
DAMAGE CONTROL REPORTS YOUR VESSEL DAMAGE AT:   45.269

RANGE TO TARGET:   141.4019
RELATIVE VELOCITY:    4
ACTION ?3
SCANNERS REPORT ENEMY DAMAGE NOW:   144.1723
ENEMY VESSEL DESTROYED
DAMAGE CONTROL REPORTS YOUR VESSEL DAMAGE AT:    140.0901
YOUR VESSEL HAS BEEN DESTROYED
 ANOTHER BATTLE ?NO
TRY AGAIN LATER!
```

DEEPSPACE PROGRAM LISTING

```
600 GO TO 640
610 PRINT "DO YOU WISH A MANEUVER CHART";\INPUT M$
620IF M$="YES" THEN 640
630 GO TO 770
640 PRINT "                    **************"
650 PRINT "    MANEUVER CHART  "
660 PRINT
670 PRINT " 1      FIRE PHASERS"
680 PRINT " 2      FIRE ANTI-MATTER MISSILE"
690 PRINT " 3      FIRE HYPERSPACE LANCE"
700 PRINT " 4      FIRE PHOTON TORPEDO"
710 PRINT " 5      ACTIVATE HYPERON NEUTRALIZATION FIELD"
720 PRINT " 6      SELF-DESTRUCT"
730 PRINT " 7      CHANGE VELOCITY"
740 PRINT " 8      DISENGAGE"
750 PRINT " 9      PROCEED"
760 PRINT
770 PRINT"YOU HAVE A CHOICE OF THREE SYSTEMS TO PATROL."
780 PRINT"1 ORION"
790 PRINT"2 DENEB"
800 PRINT"3 ARCTURUS"
810 PRINT "SELECT A SYSTEM(1-3)";\INPUT S9
820 IF S9=1 THEN 2380
830 IF S9=2 THEN 2430
840 GO TO 2480
850 D0=0
860 D1=0
870 N1=0
880 N2=0
890 N3=0
900 N4=0
910 D=0
920 PRINT"WHICH SPACECRAFT WOULD YOU LIKE.(1-3)";\INPUT S
930 IF S=1 THEN 1790
940 IF S=2 THEN 1830
950 IF S=3 THEN 1870
960 GO TO 920
970 C=C0
980 PRINT"YOU HAVE ";C;"UNITS OF CARGO SPACE TO FILL WITH WEAPONRY."
990 PRINT"CHOOSE A WEAPON AND THE AMOUNT YOU WISH.";\INPUT W,N
1000 IF W=1 THEN 1910
1010 IF W=2 THEN 2010
1020 IF W=3 THEN 2100
1030 IF W=4 THEN 2190
1040 IF W=5 THEN 2280
1050 GO TO 980
1060 IF N*C1>C THEN 2530
1070 C=C-N*C1
1080 IF W=1 THEN 1990
1090 IF W=2 THEN 2080
1100 IF W=3 THEN 2170
1110 IF W=4 THEN 2260
1120 GO TO 2360
1130 IF C>1 THEN 980
1140 REM
1150 S1=S0*RND(0)
1160 R=(3*RND(0) +5)*100
1170 PRINT
1180 PRINT "RANGE TO TARGET:";R
1190 PRINT "RELATIVE VELOCITY:";S1
1200 PRINT"ACTION";\INPUT M
1210 IF M=1 THEN 1940
1220 IF M=2 THEN 2030
1230 IF M=3 THEN 2120
1240 IF M=4 THEN 2210
1250 IF M=5 THEN 2310
1260 IF M=6 THEN 1660
1270 IF M=7 THEN 1390
1280 IF M=8 THEN 2760
1290 IF R<500 THEN 1500
1300 IF S1>0 THEN 1330
1310 R=R+(S1*8.3)^1.25
1320 GO TO 1340
1330 R=R-(S1*8.3)^1.25
1340 IF R>1500 THEN 2590
1350 IF R>0 THEN 1370
1360 R=-R
1370 PRINT
1380 GO TO 1180
1390PRINT"CHANGE TO BE EFFECTED";\INPUT S2
1400 IF (S1+S2)>S0 THEN 2550
1410 S1=S1+S2
1420 GO TO 1180
1430 F0=P1*(Z/R)^1.5
1440 REM
1450 D0=(2*F0+3*F0*RND(0))/5
1460D=D+D0
1470 PRINT"SCANNERS REPORT ENEMY DAMAGE NOW:";D
1480 IF D>99 THEN 2720
1490 GO TO 1510
1500 D0=0
1510 REM
1520 K=E1+E2*RND(0)
1530 REM
1540 E=E3+E4*RND(0)+5/P0*RND(0)
1550 REM
1560 F3=E*(K/R)^1.85
1570 D2=(3*F3+3*F3*RND(0))/5.5
1580 D1=D1+D2
1590 IF (Z*D0)/(R*500)>2.2 THEN 1620
1600 D3=D0*2/(R^2*P0)
1610 D1=D1+D3
1620 PRINT"DAMAGE CONTROL REPORTS YOUR VESSEL DAMAGE AT:";D1
1630 IF D1>99 THEN 2740
1640 IF D>99 THEN 2760
1650 GO TO 1300
1660 PRINT "SELF DESTRUCT FAILSAFE ACTIVATED!!"
1670 PRINT"INPUT 1 TO RELEASE FAILSAFE"\INPUT U
1680 IF U=1 THEN 1700
1690 GO TO 1290
1700 PRINT "SELF DESTRUCT ACCOMPLISHED"
1710 IF R>60 THEN 1740
1720 PRINT"ENEMY VESSEL ALSO DESTROYED"
1730 GO TO 2760
1740 D4=3200/R
1750 D=D+D4
1760 IF D>99 THEN 1720
1770 PRINT"ENEMY VESSEL SURVIVES WITH";D;"DAMAGE"
1780 GO TO 2760
1790 S0=10
1800 C0=16
1810 P0=1
1820 GO TO 970
1830 S0=4
1840 C0=24
1850 P0=2
1860 GO TO 970
1870 S0=2
1880C0=30
1890 P0=5
1900 GO TO 970
1910 C1=.12
1920N=100
1930 GO TO 1060
1940 P1=4
1950 IF N1=0 THEN 2610
1960 N1=N1-1
1970 Z=200
1980 GO TO 1430
1990 N1=N1+N
2000 GO TO 1130
2010 C1=4
2020 GO TO 1060
2030 P1=20
2040 IF N2=0THEN 2640
2050 N2=N2-1
2060 Z=500
2070 GO TO 1430
2080 N2=N2+N
2090 GO TO 1130
2100 C1=4
2110 GO TO 1060
2120 P1=16
2130 IF N3=0 THEN 2660
2140 N3=N3-1
2150 Z=550
2160 GO TO 1430
2170 N3=N3+N
2180 GO TO 1130
2190 C1=2
2200 GO TO 1060
2210 P1=10
2220 IF N4=0 THEN 2680
2230 N4=N4-1
2240 Z=400
2250 GO TO 1430
2260 N4=N4+N
2270 GO TO 1130
2280 C1=.20
2290 N=100
2300 GO TO 1060
2310 P1=6
2320 IF N5=0 THEN 2700
2330 N5=N5-1
2340 Z=250
2350 GO TO 1430
2360 N5=N5+N
2370 GO TO 1130
2380 E1=150
2390 E2=500
2400 E3=3
2410 E4=4
2420 GO TO 850
2430 E1=200
2440 E2=350
2450 E3=4
2460E4=3
2470 GO TO 850
2480 E1=150
2490 E2=400
2500 E3=5
2510 E4=2
2520 GO TO 850
2530 PRINT"NOT ENOUGH SPACE. RESELECT"
2540 GO TO 980
2550 PRINT"CHANGE BEYOND MAXIMUM POSSIBLE"
2560 PRINT"INCREASING TO MAXIMUM"
2570 S1=S0
2580 GO TO 1300
2590 PRINT"OUT OF SENSOR RANGE.AUTOMATIC DISENGAGE."
2600 GO TO 2760
2610 PRINT"PHASER BANKS DRAINED"
2620 PRINT"SELECT ANOTHER COURSE OF ACTION"
2630 GO TO 1200
2640 PRINT" ALL ANTI-MATTER MISSLES EXPENDED"
2650 GO TO 2620
2660 PRINT"ALL HYPERSPACE LANCES EXPENDED"
2670 GO TO 2620
2680 PRINT "ALL PHOTON TORPEDO TUBES EMPTY"
2690 GO TO 2620
2700 PRINT "HYPERON NEUTRALIZATION FIELD DRAINED"
2710 GO TO 2620
2720 PRINT "ENEMY VESSEL DESTROYED"
2730 GO TO 1510
2740 PRINT"YOUR VESSEL HAS BEEN DESTROYED"
2750 GO TO 2760
2760 PRINT" ANOTHER BATTLE";\INPUT R$
2770 IF R$="YES" THEN 810
2780 PRINT"TRY AGAIN LATER!"
2790 END
```

Another new game from Creative Computing . . . .

BOBSTONES

Dohn Addleman
Pennsylvania Dept. of Education

The idea for this new number game was derived from a contest called "Bobstones" as described in the novel, *Watership Down.* Playing rules and description are in the remarks portion of the program listing.

Suggestions:

A. Play the game against the computer.

B. Once you are familiar with the rules, play the game with a friend and use real dice.

C. Incorporate the following modifications into the program:

1. Update the program so that the players can vary the number of points needed to win.
2. Update the program so that if a tie results, the winner must win by two points.
3. Update the program so that it will verify that the human is recording the computer's responses correctly.
4. Update the program to record the most recent sums of the dice rolls. Then, the computer can use this information to determine the probability of the next roll being odd or even.

PROGRAM LISTING

```
1 REM     THIS IS A NUMBER GAME CALLED 'BOBSTONES'.  THE IDEA FOR THIS
2 REM  GAME DERIVED FROM A CONTEST CALLED 'BOBSTONES' DESCRIBED IN THE
3 REM  NOVEL "WATERSHIP DOWN".
4 REM     THIS IS THE LISTING OF THE BASIC LANGUAGE SOURCE CODE.  THE
5 REM  LISTING CAN BE DIVIDED INTO FOUR SECTIONS.  LINES 100 THRU 640
6 REM  PERTAIN TO GAME INSTRUCTIONS, DATA VARIABLE INITIALIZATION,
7 REM  PRINTING THE SCORE AND DETERMINATION OF THE PLAYERS' TURNS.
8 REM  LINES 650 THRU 1150 PERTAIN TO THE HUMAN PLAYER.  LINES
9 REM  1160 THRU 1890 PERTAIN TO THE COMPUTER AS A PLAYER.  LINES
10 REM  1900 THRU 2050 DEAL WITH RESOLUTION OF TIES AND DETERMINATION
11 REM  OF THE WINNER.
12 REM
13 REM
14 REM  FIRST SECTION - LINES 100 THRU 640
15 REM   1.   INSTRUCTIONS
16 REM   2.   INITIALIZATION
17 REM   3.   WHO GOES FIRST ?
18 REM   4.   COMPUTER SIMULATES ROLL OF DICE
19 REM   5.   PRINT GAME SCORE ?
20 REM   6.   IS GAME POSSIBLY OVER ?
21 REM
22 REM
23 REM  SECOND SECTION - LINES 650 THRU 1150
24 REM   1.   HUMAN GUESSES IF SUM OF DICE IS ODD OR EVEN
25 REM   2.   IS RESPONSE APPROPRIATE ?
26 REM   3.   COMPUTER TELLS HUMAN IF RIGHT OR WRONG AND ADJUSTS SCORE
27 REM        IF CORRECT GUESS
28 REM   4.   HUMAN GUESSES SUM OF DICE
29 REM   5.   IS RESPONSE APPROPRIATE ?
30 REM   6.   COMPUTER TELLS HUMAN IF RIGHT OR WRONG AND ADJUSTS SCORE
31 REM        IF CORRECT GUESS
32 REM   7.   IS RESPONSE APPROPRIATE ?
33 REM   8.   COMPUTER TELLS HUMAN IF RIGHT OR WRONG AND ADJUSTS SCORE
34 REM        IF CORRECT GUESS
35 REM   9.   GO TO NEXT ROLL OF DICE
```

LISTING continues on next page

SAMPLE RUN

```
*RUN

    THIS IS A NUMBER GAME CALLED BOBSTONES.  THE OBJECT OF
BOBSTONES IS TO GUESS THREE THINGS ABOUT THE ROLL OF A PAIR
OF DICE.  ON EACH TURN, THE COMPUTER SIMULATES THE ROLL OF
THE DICE.  THEN, YOU OR THE COMPUTER (YOUR OPPONENT) GUESS

                                                     SCORE
 1. IF THE SUM OF THE DICE IS ODD OR EVEN           1 POINT
 2. THE SUM OF THE DICE                             2 POINTS
 3. THE NUMBER ON EACH OF THE TWO DICE              3 POINTS

    THE WINNER IS THE FIRST PLAYER TO SCORE 11 POINTS.  IF A
TIE RESULTS, THE WINNER IS THE FIRST PLAYER TO BREAK THE TIE.
    GOOD LUCK !


YOU FIRST OR ME
?ME

YOUR TURN.
IS THE SUM ODD OR EVEN
?ODD
YOU ARE CORRECT.
NOW, GUESS THE SUM
?7
SORRY, THE SUM IS  5 .

MY TURN.
*** ON THIS ROLL OF THE DICE, THE TWO NUMBERS ARE  2   AND  2  .
*** THE SUM IS  4 .
MY GUESS IS THAT THE SUM IS EVEN.
AM I RIGHT OR WRONG
?RIGHT
MY GUESS OF THE SUM IS  2
AM I RIGHT OR WRONG
?WRONG

THE SCORE IS ME 1  - YOU 1 .

YOUR TURN.
IS THE SUM ODD OR EVEN
?ODD
YOU ARE CORRECT.
NOW, GUESS THE SUM
?7
SORRY, THE SUM IS  11

MY TURN.
*** ON THIS ROLL OF THE DICE, THE TWO NUMBERS ARE  6   AND  6  .
*** THE SUM IS  12    .
MY GUESS IS THAT THE SUM IS EVEN.
AM I RIGHT OR WRONG
?RIGHT
MY GUESS OF THE SUM IS  12
AM I RIGHT OR WRONG
?RIGHT
MY GUESS IS THAT THE NUMBERS ARE  6  AND  6  .
AM I RIGHT OR WRONG
?RIGHT

THE SCORE IS ME 7  - YOU 2 .

YOUR TURN.
IS THE SUM ODD OR EVEN
?ODD
YOU ARE CORRECT.
NOW, GUESS THE SUM
?9,
 INVALID DATUM
 ?9
SORRY, THE SUM IS  7 .

MY TURN.
*** ON THIS ROLL OF THE DICE, THE TWO NUMBERS ARE  1   AND  4  .
*** THE SUM IS  5 .
MY GUESS IS THAT THE SUM IS ODD.
AM I RIGHT OR WRONG
?RIGHT
MY GUESS OF THE SUM IS  7
AM I RIGHT OR WRONG
?WRONG

THE SCORE IS ME 8  - YOU 3 .

YOUR TURN.
IS THE SUM ODD OR EVEN
?EVEN
SORRY, THE SUM IS 3  .

MY TURN.
*** ON THIS ROLL OF THE DICE, THE TWO NUMBERS ARE  5   AND  6  .
*** THE SUM IS  11    .
MY GUESS IS THAT THE SUM IS ODD.
AM I RIGHT OR WRONG
?RIGHT
MY GUESS OF THE SUM IS  11
AM I RIGHT OR WRONG
?RIGHT
MY GUESS IS THAT THE NUMBERS ARE  5  AND  6  .
AM I RIGHT OR WRONG
?RIGHT

THE SCORE IS ME 14    - YOU 3 .

I WIN! ANOTHER GAME?
?NO
SEE YOU LATER.
 *
```

BOBSTONES
PROGRAM LISTING

```
36 REM
37 REM
38 REM  THIRD SECTION - LINES 1160 THRU 1890
39 REM   1.   COMPUTER TELLS HUMAN THE NUMBERS OF THE ROLL OF THE DICE
40 REM        AND THE SUM
41 REM   2.   COMPUTER (AS PLAYER) GUESSES IF SUM ODD OR EVEN
42 REM   3.   COMPUTER ASKS HUMAN IF ITS GUESS RIGHT OR WRONG
43 REM   4.   HUMAN RESPONDS AND SCORE IS ADJUSTED IF COMPUTER GUESSED
44 REM        CORRECTLY
45 REM   5.   COMPUTER GUESSES THE SUM OF THE DICE.
46 REM   6.   COMPUTER ASKS HUMAN IF ITS GUESS RIGHT OR WRONG
47 REM   7.   HUMAN RESPONDS AND SCORE IS ADJUSTED IF COMPUTER GUESSED
48 REM        CORRECTLY
49 REM   8.   COMPUTER GUESSES OR KNOWS THE NUMBERS FOR THIS ROLL OF THE
50 REM        DICE
51 REM   9.   COMPUTER ASKS HUMAN IF ITS GUESS RIGHT OR WRONG
52 REM  10.   HUMAN RESPONDS AND SCORE IS ADJUSTED IF COMPUTER GUESSED
53 REM        CORRECTLY
54 REM  11.   GO TO NEXT ROLL OF DICE
55 REM
56 REM
57 REM  FOURTH SECTION - LINES 1900 THRU 2050
58 REM   1.   IS GAME TIED ?
59 REM   2.   IF NO TIE, WINNER IS DETERMINED
60 REM   3.   HUMAN ASKED TO PLAY ANOTHER GAME
100 REM
110 REM FIRST SECTION.
120 REM
130 PRINT
140 PRINT "     THIS IS A NUMBER GAME CALLED BOBSTONES.  THE OBJECT OF"
150 PRINT "BOBSTONES IS TO GUESS THREE THINGS ABOUT THE ROLL OF A PAIR"
160 PRINT "OF DICE.  ON EACH TURN, THE COMPUTER SIMULATES THE ROLL OF"
170 PRINT "THE DICE.  THEN, YOU OR THE COMPUTER (YOUR OPPONENT) GUESS"
180 PRINT
190 PRINT "                                                     SCORE"
200 PRINT " 1. IF THE SUM OF THE DICE IS ODD OR EVEN           1 POINT"
210 PRINT " 2. THE SUM OF THE DICE                             2 POINTS"
220 PRINT " 3. THE NUMBER ON EACH OF THE TWO DICE              3 POINTS"
230 PRINT
240 PRINT "     THE WINNER IS THE FIRST PLAYER TO SCORE 11 POINTS.  IF A"
250 PRINT "TIE RESULTS, THE WINNER IS THE FIRST PLAYER TO BREAK THE TIE."
260 PRINT "     GOOD LUCK !"
270 DEF FND(X)=INT(6*RND(X)+1)
280 DIM A(2)
290 LET A(1)=0
300 LET A(2)=0
310 LET Z1=-1
320 LET Z2=-1
330 LET Z3=-1
340 LET Z4=-1
350 LET Z5=-1
360 LET J1=0
370 PRINT
380 PRINT
390 PRINT "YOU FIRST OR ME"
400 INPUT Z$
410 IF Z$="YOU" THEN 450
420 IF Z$="ME" THEN 450
430 PRINT "/// TYPE THE WORD 'YOU' OR THE WORD 'ME'."
440 GOTO 390
450 LET D1=FND(Z1)
460 IF Z1=0 THEN 480
470 LET Z1=0
480 LET D2=FND(0)
490 LET S=D1+D2
500 IF J1=0 THEN 650
510 IF Z$<>"ME" THEN 580
520 IF J2<>0 THEN 1160
530 PRINT
540 PRINT "THE SCORE IS ME";A(2);" - YOU";A(1);"."
550 IF A(1)>=11 THEN 1900
560 IF A(2)>=11 THEN 1900
570 GOTO 670
580 IF Z$<>"YOU" THEN 2020
590 IF J2<>1 THEN 670
600 PRINT
610 PRINT "THE SCORE IS YOU";A(1);" - ME";A(2);"."
620 IF A(1)>=11 THEN 1900
630 IF A(2)>=11 THEN 1900
640 GOTO 1160
650 LET J1=-1
660 IF Z$="YOU" THEN 1160
670 PRINT
680 PRINT "YOUR TURN."
690 LET J2=1
700 LET R=S-(INT(S/2)*2)
710 PRINT "IS THE SUM ODD OR EVEN"
720 INPUT A$
730 IF A$="ODD" THEN 770
740 IF A$="EVEN" THEN 800
750 PRINT "/// TYPE THE WORD 'ODD' OR THE WORD 'EVEN'."
760 GOTO 710
770 IF R=1 THEN 820
780 PRINT "SORRY, THE SUM IS";S;"."
790 GOTO 450
800 IF R=0 THEN 820
810 GOTO 780
820 PRINT "YOU ARE CORRECT."
830 LET A(1)=A(1)+1
840 PRINT "NOW, GUESS THE SUM"
850 INPUT G1
860 IF G1<2 THEN 890
870 IF G1>12 THEN 890
880 GOTO 910
890 PRINT "/// THE SUM MUST BE BETWEEN 2 AND 12."
900 GOTO 840
910 IF G1=S THEN 940
920 PRINT "SORRY, THE SUM IS ";S;"."
930 GOTO 450
940 PRINT "YOU ARE CORRECT."
950 LET A(1)=A(1)+2
960 PRINT "WHAT ARE THE TWO NUMBERS WHICH PRODUCED  ";S
970 INPUT N1,N2
980 IF N1<1 THEN 1030
990 IF N2<1 THEN 1030
1000 IF N1>6 THEN 1030
1010 IF N2>6 THEN 1030
1020 GOTO 1050
1030 PRINT "/// THE NUMBERS MUST BE BETWEEN 1 AND 6."
1040 GOTO 960
1050 IF N1=D1 THEN 1090
1060 IF N2=D1 THEN 1110
1070 PRINT "SORRY, THE NUMBERS ARE ";D1;" AND ";D2;"."
1080 GOTO 450
1090 IF N2=D2 THEN 1130
1100 GOTO 1070
1110 IF N1=D2 THEN 1130
1120 GOTO 1070
1130 PRINT "YOU ARE CORRECT."
1140 LET A(1)=A(1)+3
1150 GOTO 450
1160 LET J2=0
1170 PRINT
1180 PRINT "MY TURN."
1190 PRINT "*** ON THIS ROLL OF THE DICE, THE TWO NUMBERS
        ARE ";D1;" AND ";D2;"."
1200 PRINT "*** THE SUM IS ";S;"."
1210 LET A1=INT(2*RND(Z2)+1)
1220 IF Z2=0 THEN 1240
1230 LET Z2=0
1240 IF A1=1 THEN 1270
1250 PRINT "MY GUESS IS THAT THE SUM IS ODD."
1260 GOTO 1280
1270 PRINT "MY GUESS IS THAT THE SUM IS EVEN."
1280 PRINT "AM I RIGHT OR WRONG"
1290 INPUT D$
1300 IF D$="RIGHT" THEN 1340
1310 IF D$="WRONG" THEN 450
1320 PRINT "/// TYPE THE WORD 'RIGHT' OR THE WORD 'WRONG'."
1330 GOTO 1280
1340 LET A(2)=A(2)+1
1350 IF A1=1 THEN 1410
1360 LET B1=INT(5*RND(Z3)+1)
1370 IF Z3=0 THEN 1390
1380 LET Z3=0
1390 LET B2=B1+B1+1
1400 GOTO 1430
1410 LET B1=FND(0)
1420 LET B2=B1+B1
1430 PRINT "MY GUESS OF THE SUM IS ";B2
1440 PRINT "AM I RIGHT OR WRONG"
1450 INPUT D$
1460 IF D$="RIGHT" THEN 1500
1470 IF D$="WRONG" THEN 450
1480 PRINT "/// TYPE THE WORD 'RIGHT' OR THE WORD 'WRONG'."
1490 GOTO 1440
1500 LET A(2)=A(2)+2
1510 IF B2<>2 THEN 1550
1520 LET C1=1
1530 LET C2=1
1540 GOTO 1810
1550 IF B2<>3 THEN 1590
1560 LET C1=1
1570 LET C2=2
1580 GOTO 1810
1590 IF B2<>11 THEN 1630
1600 LET C1=5
1610 LET C2=6
1620 GOTO 1810
1630 IF B2<>12 THEN 1670
1640 LET C1=6
1650 LET C2=6
1660 GOTO 1810
1670 IF B2>7 THEN 1740
1680 LET K1=B2-1
1690 LET C1=INT(K1*RND(Z4)+1)
1700 IF Z4=0 THEN 1720
1710 LET Z4=0
1720 LET C2=B2-C1
1730 GOTO 1810
1740 LET K1=B2-6
1750 LET K3=K1-1
1760 LET K2=7-K1
1770 LET C1=(INT(K2*RND(Z5)+1)+K3)
1780 IF Z5=0 THEN 1800
1790 LET Z5=0
1800 LET C2=B2-C1
1810 PRINT "MY GUESS IS THAT THE NUMBERS ARE ";C1;" AND ";C2;"."
1820 PRINT "AM I RIGHT OR WRONG"
1830 INPUT D$
1840 IF D$="RIGHT" THEN 1880
1850 IF D$="WRONG" THEN 450
1860 PRINT "/// TYPE THE WORD 'RIGHT' OR THE WORD 'WRONG'."
1870 GOTO 1820
1880 LET A(2)=A(2)+3
1890 GOTO 450
1900 IF A(1)<>A(2) THEN 1930
1910 IF J2<>0 THEN 1160
1920 GOTO 670
1930 IF A(1)>A(2) THEN 2030
1940 PRINT
1950 PRINT "I WIN! ANOTHER GAME?"
1960 INPUT C$
1970 IF C$="YES" THEN 290
1980 IF C$="NO" THEN 2010
1990 PRINT "/// TYPE THE WORD 'YES' OR THE WORD 'NO'."
2000 GOTO 1960
2010 PRINT "SEE YOU LATER."
2020 END
2030 PRINT
2040 PRINT "YOU WIN! ANOTHER GAME?"
2050 GOTO 1960
```

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CREATIVE COMPUTING
Feature Review

Herbert Dreyfus reviews two books by Marvin Minsky, Seymour Papert, and Patrick Winston.

Artificial Intelligence, Marvin Minsky and Seymour Papert, 61 pp., $2.00, Condon Lectures, Oregon State System of Higher Education, Eugene, Oregon, 97403, 1974.[1]

The Psychology of Computer Vision, Ed. Patrick Henry Winston, 280 pp., $19.50, McGraw-Hill, 1221 Avenue of the Americas, New York, N. Y., 10020, 1975.

These two books reveal that an important change has taken place at the MIT AI laboratory during the past five years. In previous works, e.g. *Semantic Information Processing* (1968)[2] Minsky and his co-workers sharply distinguished themselves from workers in Cognitive Simulation who presented their programs as psychological theories, insisting that the MIT programs were "an attempt to build intelligent machines without any prejudice toward making the system...humanoid."[3] Now the prefact to *Artificial Intelligence* states, "the primary use of computers for research into the nature of intelligence is that of simulation,"[4] and Minsky and Papert attempt to argue for the role of symbolic representations in intelligent behavior by a constant polemic against behaviorism and gestalt psychology. Likewise Winston claims, in support of his collection of papers on computer vision, that "Making machines see is an important way to understand how we animals see."[5]

"Computer science has brought a flood of...ideas, well defined and experimentally implemented, for thinking about thinking..."

Underlying this change one can detect the effect of ten years of growing success in the manipulation of *ad hoc* micro-worlds, accompanied by a decade of failure to produce a single system which even begins to approach the adaptability to changing contexts shown by a dog, a cat, or a six months old child. Instead of concluding from this frustrating situation that the machine techniques which work in context-free, game-like, micro-worlds may in no way resemble human and animal intelligence, the AI workers have taken the less embarrassing tack of suggesting that even if they cannot succeed in building intelligent systems, the techniques so successful in micro-world analysis can be justified as a valuable contribution to psychology.

Such a pitch, however, since it involves a stronger claim than the old slogan "that as long as the machine was intelligent it did not matter at all whether it performed in a humanoid way," runs the obvious risk of refutation by empirical evidence. The risk is especially great at this moment when recent work in Cognitive Psychology on the role of rotation of images in pattern recognition (Shepard)[6] and the discovery of the use of stereotypical images in categorization (Rosch)[7], has led many cognitive psychologists to reevaluate the explanatory power of a formal model of perception and cognition.

Compelled by the formal nature of any computer model, however, Minsky and Papert take an unquestioning stand in favor of abstract, symbolic representations, and against concrete, physical, perceptual processes. Thus making a virtue of necessity, they revive the intellectualist position of Kant's *Critique of Pure Reason,* according to which perception is indistinguishable from rule governed thought.

> The Gestaltists look for simple and fundamental principles about how perception is organized, and then attempt to show how symbolic reasoning can be seen as following the same principles, while we construct a complex theory of how knowledge is applied to solve intellectual problems and then attempt to show how the symbolic description that is what one "sees" is constructed according to similar such processes.[8]

But this attempt to invert the prima facae priority of perception to thinking gets Minsky and Papert into the same sort of trouble that eventually led Kant, in the *Critique of Judgement,* to give up this view. Before one can begin to select primatives in terms of which to analyze a scene, the scene must be segregated into local units and salient features. Minsky recognizes this as the gestaltists' argument for the priority of the figure-ground distinction but, on the basis of Guzman's success in the analysis of scenes involving rectilinear objects, he retorts that:

> In complex scenes, the features belonging to different objects have to be correctly segregated to be meaningful; but solving this problem—which is equivalent to the traditional Gestalt "figure-ground" problem—presupposes solutions for so many visual problems that the possibility and perhaps even the desirability of a separate recognition technique falls into question[9].

This, however, presupposes that the top-down technique of looking for edges, which works in segmenting rectilinear objects, can somehow be generalized to curved surfaces. In absence of any such techniques, the question remains how to account for the organization of the primative wholes which form the basis of higher-order recognition processes.

Recently, extension of early gestalt work on the perception of similarity of simple perceptual figures,—arising in part in response to "the frustrating efforts to teach pattern recognition to [computers]"[10]—has revealed sophisticated distinctions between figure and ground, matter and form, essential and accidental aspects, norms and distortions, etc. which are already apparent at the perceptual level even when no recognizable objects are present. Careful, empirical studies of perceptual similarity by Erich Goldmeier have demonstrated a "kind of relation between stimulus variation and phenomenal variation [which] has never been envisioned in psychological theory."[11] He has been led to conclude that these perceptual functions cannot be accounted for in terms of the rule-like relations of formal features of the stimuli, except perhaps on the neurological level, where the importance of Pragnanz or singularity suggests physical phenomena such as "regions of resonance."[12]

Minsky is aware that there are theorists who claim that the organization of perception can only be explained in terms of physical processes such as resonance and holograms, but he rejects this view with the remark that:

> The output of a quantitative mechanism, be it numerical, statistical, analog, or physical (nonsymbolic), is too structureless and uninformative to permit further analysis.[13]

But this thrice begs the question. First since it is not obvious that perception is thinking, or even that all thinking is analysis, it is not obvious that the stable patterns of perceptual organization need provide the sort of features required in higher order computation. Secondly, even if higher order objects *are* recognized in terms of features, we have just seen that concrete perceptual organization, far from being unstructured, provides the necessary structure for higher operations. Thirdly, it cuts no ice against a neurological (nonsymbolic) view that it does not permit further analysis, if this means it cannot be explained in terms of a computer program. What the gestaltists precisely question is whether perception is the sort of phenomenon amenable to formal, symbolic analysis.

Of course, it is still possible that the gestaltists went too far in trying to assimilate thought to the same sort of concrete, holistic, brain processes they found necessary to account for perception. Thus, even though the exponents of symbolic representation have no account of perceptual processes, they might be right about the mechanism of everyday thinking and learning. Such a formal model of everyday learning and recognition is proposed by Winston in his paper, "Learning Structural Description from Examples."[14]

Given a set of positive and negative instances, Winston's self proclaimed "classic" program for learning the structural description of an arch uses a small pre-selected and pre-programmed descriptive repertoire to construct a formal description of the class of arches.

But is this a plausible theory of learning? Winston ingeniously concludes that it is:

> Although this may seem like a very special kind of learning, I think the implications are far ranging, because I believe that learning by examples, learning by being told, learning by imitation, learning by reinforcement and other forms are much like one another.
>
> In the literature of learning there is frequently an unstated assumption that these various forms are fundamentally different. But I think the classical boundaries between the various kinds of learning will disappear once superficially different kinds of learning are understood in terms of processes that construct and manipulate descriptions.[15]

But, of course, this program only works if the "student" is saved the trouble of doing what Peirce called abduction, by being "told" a set of context free features and relations—in this case a list of possible spacial relationships of blocks such as contact, support and alignment—from which to build up the description. These features are just the sort of prominences formed in perception by repeated experience. Minsky and Papert in their account of this program don't seem to notice that without this pre-programmed "training" it would make no sense to say that "to eliminate objects which seem atypical...[the] program lists all relationships exhibited by more than half of the candidates in the set."[16] Without perceptual saliences all the objects share an indefinitely large number of relationships.

Is this then perhaps at least a plausible theory of categorization? Once it has been given what Winston disarmingly calls a "good description"[17] and carefully chosen examples, the program indeed concludes that an arch is a structure in which a prismatic body is supported by two upright blocks that do not touch one another. But even Winston admits that having two supports and a top does not begin to capture even the geometrical structure of arches, many of which are curved. So Winston proposes to "generalize the machine's description attributes to acts and properties required by those acts"[18], adding some *ad hoc* predicate like "something to walk through"[19].

But it is not at all clear how the above predicate which refers to implicit knowledge of the bodily skill of "walking through" is to be formalized. Indeed, Winston himself provides a *reductio ad absurdum* of this facile appeal to formal predicates:

> To a human, an arch may be something to walk through, as well as an appropriate alignment of bricks. And certainly, a flat rock serves as a table to a hungry person, although far removed from the image the word *table* usually calls to mind.
>
> But the machine does not yet know anything of walking or eating, so the programs discussed here handle only some of the physical aspects of these human notions. There is no inherent obstacle forbidding the machine to enjoy functional understanding. It is a matter of generalizing the machine's descriptive ability to acts and properties required by those acts. Then chains of pointers can link TABLE to FOOD as well as to the physical image of a table, and the machine will be perfectly happy to draw up its chair to a flat rock with the human, given that there is something on that table which it wishes to eat.[20]

One can't help feeling, when Winston ends his praise of Minsky's "first step" with the challenge: "Much remains to be done," that this is just a tactful way of saying: "Nothing has been accomplished."

Further work on recognition of arches, tables, etc. must, it seems, either wait until we have captured in an abstract symbolic description all that human beings implicitly know simply by having a body, or else until computers no longer have to be told what it is to walk and eat, because they have human bodies and appetites themselves!

In the meantime Winston's proposal cannot be considered a contribution to a theory of learning and recognition until he solves the following fundamental problems:

(1) The program can only learn even a simplified geometrical concept like arch if the programmer, using his everyday understanding, makes explicit and pre-selects a small set of relevant features to "tell" the program. There is no sign how programs could acquire these features.

(2) To distinguish accidental from essential features the program pre-weights its primitives. Once we see how arches function in our everyday activities, there is no reason to suppose that there is *any* set of necessary and sufficient conditions for defining our everyday notion of an arch, and in any case Winston gives us no idea how the program could assign these weights.

(3) The prominent characteristics shared by some everyday arches are "helping to support something while leaving an important open space under it," or "being the sort of thing one can walk under and through at the same time." How does Winston propose to convert such characteristics into the definable, context-free features required by a formal representation?

Despite these seemingly insurmountable obstacles Winston boasts that "there will be no contentment with [concept learning] machines that only do as well as humans."[21] In fact, there has been little progress in machine learning, induction, or concept formation. Indeed, Minsky and Papert admit that "we are still far from knowing how to design a powerful yet subtle and sensitive inductive learning program."[22] What is surprising is that they add "but the schemata developed in Winston's work should take us a substantial part of the way."[23] The lack of progress in the seven years since Winston's work was published, plus the total dependence of the program on a human programmer to provide the primitives from which it can produce its rigid, restricted, and largely irrelevant descriptions, makes it hard to understand in what way the program is a substantial first step.

Moreover, if Winston claims to "shed some light on" the question: "How do we recognize examples of various concepts?"[24] his theory must, like any psychological theory, be subject to empirical test. It so happens that contrary to Winston's claims, recent evidence collected and analyzed by Eleanor Rosch on just this subject has tended to establish that recognition of basic objects such as chairs and tables does not depend on learning which features define the concept, but on seeing them as more or less distant from an imagined paradigm:

> Many experiments have shown that categories appear to be coded in the mind neither by means of lists of each individual member of the category, nor by means of a list of formal criteria necessary and sufficient for category membership, but, rather, in terms of a prototype of a typical category member. The most cognitive economical code for a category is, in fact, a *concrete image* of an average category member.[25]

This research suggests that we had better look to Minsky's more recent proposal for using frames, or prototypes, to represent everyday knowledge for a contribution to the psychology of categorization.[26] But this ambitious proposal which Winston, graciously returning Minsky's compliment, considers "the ancestor of a wave of progress in AI,"[27] begs every fundamental question raised by Rosch's research. Indeed, a passage from Minsky's influential paper can be used to pinpoint many of the unsolved problems in the field:

> There are many forms of chairs, for example, and one should choose carefully the chair-description frames that are to be the major capitols of chair-land. These are used for rapid matching and assigning priorities to the various differences. The lower priority *features* of the *cluster* center then serve . . . as properties of the chair *types* . . .
>
> [There is no argument why we should expect to find elementary context free *features* characterizing a chair *type,* nor any suggestion as to what these features might be. They certainly cannot be legs, back, seat, etc. since these aspects of chairs are not context-free features defined apart from chairs, which then clustered in a chair representation.]
>
> Difference could be functional as well as geometric. Thus, after rejecting a first try at "chair" one might try the functional idea of "something one can sit on" to explain an unconventional form.
>
> [A function so defined is not abstractable from human embodied know-how and cultural practices. If it is treated as an additional symbolic description along with physical features, function cannot even distinguish conventional chair shapes from toilets, thrones, and seats.]
>
> Of course, that analysis would fail to capture toy chairs, or chairs of such ornamental delicacy that their actual use would be unthinkable. These would be better handled by the method of excuses, in which one would bypass the usual geometrical or functional explanation in favor of responding to *contexts* involving *art* or *play.*
>
> [This is what is required alright, but by what elementary features are these contexts to be recognized? There is no reason at all to suppose that one can avoid the difficulty of formally representing a chair by abstractly representing even more holistic, concrete, culturally determined, and loosely organized human practices such as art and play.][28]

This passage, and other such observations as "trading normally occurs in a social context of law, trust, and convention. Unless we also represent these other facts, most trade transactions will be almost meaningless,"[29] show that Minsky has understood the lesson of my book, *What Computers Can't Do,* which argued that intelligent behavior requires as background the totality of practices which make up the human way of being in the world. But Minsky seems oblivious to the hand waving character of his proposal that frames will enable workers in AI to represent all this background in explicit descriptions, as if the programmers could make explicit the totality of activities which they have picked up by training without recourse to explanations or descriptions, and which pervades their life as water encompasses the life of a fish. In the light of the fundamental unavailability of this tacit know-how, one can't help feeling, when Winston ends his praise of Minsky's "first step" with the challenge: "Much remains to be done,"[30] that this is just a tactful way of saying: "Nothing has been accomplished."

One might retrench once more, however, and claim that, although common sense categorization of chairs and tables is too concrete and tied in with human practices to be amenable to formal representation, one might still produce a formal model of pure thought. In that case, science would seem to be an ideal subject for computer simulation, since as a detached theoretical enterprise it deals with context-free attributes, whose law-like relations can, in principle, be grasped by any sufficiently powerful intellect, whether human, Martian, digital, or divine.

Yet, according to philosophers and historians of science, even scientific research requires concrete paradigms for its success. Just as everyday problem solving and more developed forms of technology take place in a practical context which makes possible *insight* into which aspects of objects are *significant* for the task at hand, so *all* appeal to attributes whether practical or theoretical requires *abduction* to exclude from consideration all but a limited number of the possibly *relevant* factors. In science this job is done by an implicitly agreed upon paradigm of successful scientific practice which leads the scientist to notice only a pre-selected sub-set of the possibly relevant factors. Otherwise, the scientist is as hopelessly lost as a Martian or computer. As Thomas Kuhn notes: "In the absence of a paradigm or some candidate for paradigm, all the facts that could possibly pertain to the development of a given science are likely to seem equally relevant."[31]

Minsky in his frames article claims that: "the frame idea. . .is in the tradition of. . .the 'paradigms' of Kuhn."[32] It is thus instructive to see how a theory of formal representation such as Minsky's misses the point of Kuhn's analysis. After quoting Kuhn's description of a "paradigm-induced gestalt switch,"[33] Minsky interprets as follows:

> According to Kuhn's model of scientific evolution "normal" science proceeds by using established *descriptive schemes.* Major changes result from new "paradigms," new ways of describing things that lead to new methods and techniques. . . Whenever our customary viewpoints do not work well, whenever we fail to find effective frame systems in memory, we must construct new ones that bring out the right *features.*[34]

But what Minsky leaves out is precisely Kuhn's claim that a paradigm is not an abstract descriptive scheme in terms of formal features, but a set of shared concrete practices, Indeed, a commonly accepted example of good work, in order to perform its function of providing continuity of agreement, cannot and must not be "rationalized," i.e. made explicit and abstracted from accepted examples of successful science. As Kuhn puts it:

> Scientists can agree that a Newton, Lavoisier, Maxwell, or Einstein has produced an apparently permanent solution to a group of outstanding problems and still disagree, . . . about the particular abstract characteristics which make those solutions permanent. They can, that is, agree in their *identification* of a paradigm without agreeing on, or even attempting to produce, a full *interpretation* or *rationalization* of it. Lack of standard interpretation or of an agreed reduction to rules will not prevent a paradigm from guiding research. . . .Indeed the existence of a paradigm need not even imply that any full set of rules exists.[35]

The point is that even in the area of abstract thought, it is important for the development of science that the underlying practices *not* be fixed in abstract symbolic structures, for the rigidity of an explicit descriptive scheme would eliminate the necessary adaptability to new situations. That is why, as Kuhn puts it:

> Paradigms may be prior to, more binding, and more complete than any set of rules for research that could be unequivocally abstracted from them.[36]

Thus, although it is the job of scientists to find abstractible, formal explanations, and the subject matter of science consists of such formal accounts, the *work* of scientists themselves does not seem to be amenable to this sort of explanation. Indeed, if each scientist had internalized a complete formal description of the defining features of his discipline, this scheme would, as Minsky remarks, require explicit "redefining of 'normal' "[37] for each modification of scientific practice. But, according to Kuhn, this is precisely what does not occur.

What can we conclude, then, concerning the contribution of MIT AI research to the science of psychology? No one can deny Minsky and Papert's claim that "Computer science has brought a flood of... ideas, well defined and experimentally implemented, for thinking about thinking..."[38]. But all of these ideas can be boiled down to ways of constructing and manipulating symbolic descriptions, and, as we have seen, the notion that human cognition can be explained in terms of formal representations does not seem at all obvious in the face of actual research on human perception, everyday concept formation, and abstract scientific thought. Still, Minsky and Papert show a commendable new modesty. They only claim that:

> Just as astronomy succeeded astrology, following Kepler's discovery of planetary regularities, the discoveries of these many principles in empirical explorations of intellectual processes in machines *should* lead to a science, eventually.[39]

Happily, "should" has replaced "will" in their predictions. But their research actually suggests an even more modest hope: ideas derived from computer programming may lead to a science, eventually, probably at the neurological level, if psychologists only learn to profit from AI's mistakes.

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FOOTNOTES

1. Potential purchasers should be warned that these Condon Lectures (Copyright 1974) were given in 1971 and are simply a reprinting (minus chapter 6 on Winograd) of MIT MAC Memo 252 (Jan. 1, 1972). Apparently someone thought that three years after the original presentation not a word needed to be changed to bring this discussion of the state of the art in AI up to date.
2. *Semantic Information Processing,* Marvin Minsky, ed., MIT Press, Cambridge, Mass. 1968.
3. Ibid., p. 7.
4. *Artificial Intelligence,* p. 6.
. *The Psychology of Computer Vision,* p. 2
6. R.N. Shepard, and B. Metzler, "Mental Rotation of Three-Dimensional Objects," *Science,* 1971, pp. 701-703. Minsky recognizes in his frames article that "Many psychologists feel that the experiments of Shepard on matching rotated objects indicate that humans perform continuous operations upon picture-like images." (p. 273), but he dismisses this view in a few sentences. For a more detailed attempt to save formal representations in the face of the latest findings concerning images, see Zenon Pylyshyn's forthcoming paper, "Imagery and Artificial Intelligence," *Minnesota Studies in the Philosophy of Science,* Vol. IX.
7. Eleanor Rosch, "Human Categorization," in N. Warren (ed.) *Advances in Cross-Cultural Psychology* (Vol. 1), London, Academic Press, in press.
8. *Artificial Intelligence,* p. 34.
9. "A Framework for Representing Knowledge," *The Psychology of Computer Vision,* p. 215.
10. Erich Goldmeier, *Similarity in Visually Perceived Forms,* International Universities Press, New York, 1972, p. 1.
11. Ibid., p. 118.
12. Ibid., p. 128.
13. "A Framework for Representing Knowledge," p. 275.
14. *The Psychology of Computer Vision,* Chapter 5.
15. Ibid., p. 185.
16. *Artificial Intelligence,* p. 54.
17. Op. cit., p. 158.
18. Ibid., p. 194.
19. Ibid., p. 193.
20. Ibid., pp. 193-194.
21. Ibid., p. 160.
22. *Artificial Intelligence,* p. 56.
23. Ibid., p. 56.
24. Op. cit., p. 157.
25. Op. cit., preprint, p. 41.
26. "A Framework for Representing Knowledge."
27. *The Psychology of Computer Vision,* p. 16.
28. Op. cit., p. 255. My italics and square bracketed comments.
29. Ibid., p. 240.
30. Op. cit., p. 16.
31. Thomas Kuhn, *The Structqre of Scientific Revolutions,* University of Chicago Press, Chicago, Ill. 1962, p. 15.
32. Op. cit., p. 213.
33. Ibid., p. 260.
34. Ibid., p. 261. My italics.
35. Kuhn, p. 44.
36. Ibid., p. 46.
37. "A Framework for Representing Knowledge," p. 261.
38. *Artificial Intelligence,* p. 25.
39. Ibid., My italics.

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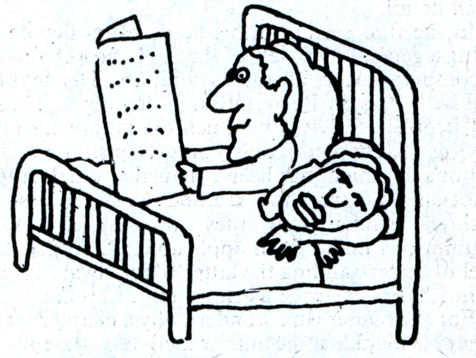
CREATIVE COMPUTING Reviews



Reviews Editor: Peter Kugel, School of Management, Boston College, Chestnut Hill, MA 02167.

Readers: Want to be a reviewer? Write to the Reviews Editor directly. Publishers: send materials for review to the Reviews Editor.

Intelligent Life In The Universe, by I. S. Shklovskii and Carl Sagan, 509 pp. $3.25. Dell Publishing Co., New York, 1966.

The Cosmic Connection: An Extraterrestrial Perspective, by Carl Sagan, 274 pp. $1.75. Dell Publishing Co., New York, 1973.

These two books are roughly parallel in structure; both cover essentially the same ground. *Intelligent Life,* a translated and annotated version of Shklovskii's Russian edition of *Universe, Life, Mind,* contains more detail and information but is somewhat awkward reading because of its annotated style. *The Cosmic Connection* is much more readable, with less detail and a clearer flow of ideas. Of the two books, I would recommend *Connection* because it is exactly this grand flow of ideas which is important.

Connection is divided into three parts: "Cosmic Perspectives", "The Solar System", and "Beyond The Solar System." Sagan is concerned with who we are, what we are and where we are going. The book is as broad as that. He touches on every aspect of life which should be of concern to intelligent beings, from the evolution of our own civilization, to a modest plan for searching for extraterrestrial life, to some really wild scenarios of possible futures.

Reading this book should be done slowly, on a quiet evening. After you have finished reading, go stand under the night sky and let all those numbers with their incredible magnitudes and implications roll around your head. Think BIG. Think on a civilization lasting for millions of years; of waiting a thousand years for a reply to a message; of what you would say in such a message that would be of value to another world. Think on Sagan's observation: "We are at an epochal, transitional moment in the history of life on Earth. There is no other time as risky, but no other time as promising for the future of life on our planet."

John Lees
Rolla, MO

Artificial Intelligence. Earl B. Hunt. 468 pp. $29.00 Academic Press, Inc., 111 Fifth Avenue, New York, N.Y. 10003 (1975).

This book fulfills a great need for a detailed description of the "state of the art" in the field of research commonly called Artificial Intelligence. There have been previously published research monographs that concentrated on specific points of view and described, to a great extent,the author's own researches - and occasionally their relation to the work of others. We also have the excellent introduction by Phillip Jackson ("Introduction to Artificial Intelligence", Petrocelli Books, New York, 1974) which provides an excellent overview but does not go into much detail.

In the first section of his book, Hunt devotes a chapter to giving a general overview of the field and a chapter to the theory of computation and formal grammars. The next three sections deal with Pattern Recognition (5 chapters), Theorem Proving and Problem Solving, in which the author also includes game playing (5 chapters) and comprehension (3 chapters). The author's treatment has been exhaustive and detailed. The reader is not only informed that methods exist. He or she is taught the methods, shown how they are applied and what basic assumptions make them applicable. Of course, at our present level of understanding the latter is not always possible—but the author has tried to be as thorough in his analysis as he could.

For the reader who wonders why a chapter on Computation Theory is included, the author includes a statement at the end of Chapter 2: "These results... tell us that there are a number of interesting problems that can not be solved by an algorithm and many that can not be solved by a simple one." The student of A.I. is warned, by this, to lower his or her sights in the interest of practicality. The author does not refer to the new results on complexity of computations—which point out that many algorithms give rise to computation times which grow very rapidly with problem size and have to be used cautiously.

It is somewhat disappointing that the section on Pattern Recognition, while containing detailed analyses of both the techniques he calls "sequential" and "grammatical," does not point out that they represent a trend towards greater and greater expressibility in the language of pattern description. Nor does he point out that the Evans program, mentioned by him in Sec. 7.2, is a step ahead of other syntactic description methods in that relations like "larger than" are as easy to use in that language as the mere "attached to" that most syntactic methods are constrained to.

This section contains, in addition to discussions of the syntactic and logical methods of description, discussions of those methods that involve statistical and algebraic techniques. A detailed discussion of Minsky and Papert's work on linearly separable functions has, laudably, been included. This is good. It is however somewhat disappointing to see that some of the work on "growing" languages (like Sherman and Ernst's work on learning concepts in terms of other concepts) has not been mentioned nor has the author pointed out the close relationship that exists between a good pattern description language and the "comprehension languages" discussed in Chapter 14.

The recent work on "algorithms for finding a minimal path to a single goal node" which has become a basis for a new theory of heuristics, is discussed in detail in Chapter 10. This yields the impression that the only theory of heuristics that is possible is numerical in nature. However, the later work of Ernst, following his GPS book with Newell, establishes a viable alternative approach.

These objections to Hunt's book are basically 'nit-picking.' Such objections are possible (or even needed) only because Dr. Hunt's book is likely to set a trend for the field for some time to come, so that in the absence of such nit-picks, some worthwhile recent approaches might get forgotten.

Hunt can be both commended and criticised for not introducing his own biases into the discussion of the overall structure of the field. He observes that "Problem solving by computers .... requires us to think simultaneously in terms of graph theory and formal logic with an occasional use of statistical reasoning ... some knowledge in a great many fields may be called for." This situation will continue to exist and one can only hope that a proper understanding of the interaction of these various fields within the field of Artificial Intelligence will be possible. Many people have conflicting views on the form this understanding will take. The author has referred to few but not to all. Given the current state of the art, perhaps it is all the better that the author's analysis has focussed on the algorithms and not in their relationship with each other.

This book will be of great value to new workers in the field. It gives a solid introduction to the techniques and conventional wisdom of the field. But it bothers me that Hunt criticises techniques developed by authors who obtained them as a side product while developing formal theories of problem solving. In Hunt's opinion, "in many specific A.I. projects the informal approach ... would have been as satisfactory as the often forbidding formalisms ..." This reviewer has by and large to agree. However, he would like to note that these highly formal techniques have yielded algorithms of some power and generality about which the general reader has the right to be told. Luckily, Hunt does make references to papers describing such work, and, through these references, to methods motivated by these formal points of view. The harm of these omissions therefore is not irreparable.

R. Banerji
Temple University, PA.

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On Machine Intelligence - Donald Michie, 199 pages, Edinburgh University Press, 22 George Square, Edinburgh. 1974. (Published in U.S. by Halstead Press, $6.95.)

As a discipline, Artificial Intelligence is not yet thirty years of age, and serious experimental and engineering work is even more recent. There have been few persons whose work on the field span this same time, yet Donald Michie stands out as one of the half dozen or so figures who symbolize schools of thought on A.I. This book is a collection of fifteen essays, arranged chronologically, which were published elsewhere from 1961 to 1974 and as such they very well portray some of the central themes of Michie's work during this period.

The early works give much attention to game playing which shifts to a more general concern for theories of learning and finally to robots (Integrated Cognitive Systems) as ideal tests for much of the working theory. It is clear from these pieces that Michie is mainly concerned with implementing theoretical developments and consequently the articles have more of an "engineering" rather than "science" bent.

In any collection of this length there is bound to be some redundancy yet on the whole the book is enjoyable and quite non-technical. "Trial and Error" and "Machines and the Theory of Intelligence" are especially good expositions, easily suitable to advanced high school students. I would think the person unfamiliar with A.I. work would gain a very good survey of the kinds of issues with which the Edinburgh group has been concerned. The essays are not technical and do not depend on any knowledge of computing. My only regret is that, as popularly written articles, they often serve only to whet the appetite.

John J. Neuhauser
Chestnut Hill, MA

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The Sun Never Sets On IBM: The Culture And Folklore Of IBM World Trade, by Nancy Foy, William Morrow & Co., Inc., 218 pp., $7.95, 1975.

Everyone knows that IBM is big, but few outsiders realize that IBM is more than just a gigantic multinational corporation. IBM is a world in itself, with its own way of doing things, its own language and customs, its own system of ethics and a surprising amount of control over how it is seen by the non-IBM world. Nancy Foy gives a glimpse into the unique entity which is IBM World Trade; the organization with the motto, "World Peace Through World Trade."

The overall impression one gains from the book is that IBM is a good company which has become almost too successful. The company has remained largely non-unionized by the method of giving its employees outstanding working conditions and job security, along with membership in the IBM extended family. IBM expects much from its employees, but it also takes care of its own. Most ex-IBMers remain quite loyal to the company.

IBM is not, however, completely independent of the outside world, it must sell products, and the outside world is changing. IBM is a growth oriented company with revenues in the billions of dollars per year and it is fast running out of room and ways to grow. Everywhere it turns, IBM faces possible anti-trust action. IBM can not even lower the prices of its own products (which in many cases it could easily afford to do) appreciably without wiping out its competitors. IBM now faces the challenge of changing its internal structure to cope with a less growth oriented world.

Nancy Foy's book is one of the few sources of information on the internal history of a company which touches everyone's lives, for IBM rarely makes public information of its own accord. *The Sun Never Sets* is also worth reading for the anecdotes and tall tales alone; the men who all dress the same, IBM's operation in World War II Europe ("some of IBM's German profits went to the Resistance"), the fantastic amounts of money involved. All in all it is a very interesting book, although one is left with the nagging feeling that a lot still remains untold.

John Lees
Rolla, MO

*****

Applications of Computer Systems, Richard A. Bassler and Edward O. Joslin (Eds.), 164 pp., $3.95, College Readings, Inc., P.O. Box 2323, Arlington, VA 22202.

A compilation of published articles on computer use in many fields, this book is intended as a text or (more likely) supplementary text to be used in a course for students already familiar with the fundamentals of computer operation to familiarize them with the types of potential applications identified in a survey of employers.

The very broad spectrum of applications represented (with excessively brief introductions to units by the compilers of the text) does serve to make readers aware of the often expressed, seldom exhibited universality of computer capabilities. In this regard, the book could prove useful to students planning to seek employment in the field.

Most of the articles are on specific applications, few lend themselves to adaptation or transfer, and the accompanying bibliography follows the same pattern—any generalization is left to the reader or his instructor. The book is probably useful in a course preparing students for supervisory roles in computer-associated fields or by employees in such positions.

John L. Randall
Kensington, MD

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The Assault on Privacy: Computers, Data Banks, and Dossiers, by Arthur R. Miller, University of Michigan Press, 1971.

While it's true that Mars is the next stop in our conquest of space, this is NOT the "space age". It is the Age of Information. I have not christened this current era nor has Professor Miller but if you read *Assault on Privacy,* you certainly will not forget it. It is not so much the information as the control of it. This detailed, and incredibly well-documented, account will give you second thoughts when you fill out forms and will send you into your own memory banks trying to recall how much information you have already, quite off-handedly, given out about yourself in the past. In fact, it probably will make your hair stand up, incense you and make you want to do something about this threatening area of American life. This is when the real problem will strike home—"what" and "how". It is to say the least overwhelming and that in itself enhances the "consciousness-raising" impact of this book. Professor Miller, after chronicling situation after offensive situation, offers the beginnings of a solution. His direction is a legal one and the one he can speak for most adequately, being a professor of law. His arguments and observations are, at times, complex and difficult to follow but the final result is rewarding if you stick with it. At first, I had a negative reaction as the book progressed but then I chalked it up to my own Americanism. By that I mean the kind of wild-west mentality that possesses each of us in a problematic situation—"there must be some kind of quick and decisive AND terminal way to handle this". Perhaps we think that no problem is worth too much thought and effort, after all, we are blessed here in the United States with invincibility. On the contrary, I feel as does Arthur Miller, that we can no longer face complex problems with simplistic approaches and that we must develop the sophistication and the follow-through to beat the "bugs" in our way of life. However, I myself want to go beyond just bureaucratic solutions and also develop a personal philosophy to maintain what is most personal in our way of life while at the same time employing the best of what technology has to offer, whatever that is. We have yet to define this or to set up the proper controls. So I suggest you read this book and that you not make it your last on the subject.

Bill Griffith
Boston College

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The Moon Is A Harsh Mistress, by Robert A. Heinlein, 302 pp. Berkley Medallion Books, New York, 1966

Robert Heinlein is of course one of the greatest science fiction writers of all time. He has in fact written a not too improbable future history of our portion of the Galaxy. *The Moon Is A Harsh Mistress* is not strictly part of Heinlein's Future History series, but it is great reading and it contains a very interesting character: Mike (short for Mycroft), a truly intelligent computer.

The story is about a revolution (The bang, bang you're dead kind. Heinlein is a rather bloodthirsty author. He would call it being realistic.) in which the penal colony on Earth's Moon tries to assert its independence and break away from Earth. The revolution is led by a cabal of three "Loonies" and Mike—a "High-Optional, Logical, Multi-Evaluating Supervisor, Mark IV, Mod L" HOLMES FOUR computer which "woke up" one day after its complexity had reached a sufficiently high level.

As Heinlein paints its personality, Mike is a child prodigy with a prankish sense of humor; no morals, no sense of right and wrong, and loyal only to the technician who recognized its sentience and took the time to talk with it as a sentient being instead of as a machine. Mike becomes the *de facto* leader of the revolution; tricking the Warden, controlling the phone network, calculating strategies, operating the Moon's only possible weapon against Earth and actually giving orders itself.

Mike is such a really lovable fellow, telling jokes, pulling pranks, writing poetry even, and is so obviously on the side of the good guys, that you tend to push to the back of your mind the fact that Mike also kills people. Now this is not to say that Mike is some kind of horrible electronic monster; if any revolution is justifiable, theirs is. Mike has simply progressed from making, for instance, inventory decisions to making life and death decisions, not always in favor of life.

So after you have enjoyed the story, spend a little time thinking about what life will mean to the first computer that wakes up. No small child understands life and death, but what small child has the power of life and death?

John Lees
Rolla, MO

*****

The Listeners, by James E. Gunn, 240 pp., $1.25, Signet Books, 1972.

The Project had been in existence for fifty years. Fifty years of listening among the thin hissing of the Galaxy for a message saying that Earth is not alone. But no message had yet come, and now Congress was balking at funding and the highbrow press was out to bury the Project as an example of fruitless waste. They said that fifty years was long enough; the scientists of the Project were prepared to wait centuries. Meanwhile, the first message had been received and was waiting to be noticed.

James Gunn presents the story of the Project through the lives caught up in it and in the message. He explores the effect which receipt of such a message might have on Earth and the effect on society of waiting more than a lifetime for a reply to be answered. Gunn takes a few technical liberties, the worst of which is assuming that such a message will take so long to decode once it is recognized as a message, but they do not get in the way of a good story.

John Lees
Rolla, MO

CREATIVE COMPUTING
Feature Review

34 Books on BASIC

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This is the 6th and final installment of this comprehensive review of 34 Books on BASIC. Several books have been published since this review was written; they will be reviewed in an Epilog in a future issue. Also, if there is sufficient demand, we will reprint the entire Group Review as a separate booklet.

28. My Computer Likes Me* (*when i speak in BASIC). Pub. 1972 by Dymax, P. O. Box 310, Menlo Park, Calif. 94025, 64 pages, 8¼ x 10¼, $1.49 (paperback).

The most elementary of all these texts. Based on a single idea (population), with too many programs using the computer just for printing. Rating: C

The text of this pulp-paper booklet is identical with (although printed more neatly than) the 1971 Dymax booklet *My Computer Understands Me.* But someone else already had the rights to that title, so it was changed. The text was written by Robert Albrecht, one of the principals of Dymax, and author of several other BASIC books (14,32).

The first thing one notices about the text is the variety of type and the ornaments used. Most of the text is Teletype print; the rest is in roman serif type. There are subheadings and notes in sans-serif, and major headings in large boldface fonts, including Old English. The ornaments run from decorative borders to pointing hands and large asterisks. Featured in several places is the almost-forgotten Kilroy symbol, with head peering over wall.

The first program is a two-liner based on PRINT "MY HUMAN UNDERSTANDS ME", with two pages of explanation. The second program is based on printing 7 + 5, with and without quote marks around the numbers, with a page of explanation. The text explains that when 7 + 5 is enclosed in quotation marks, it is a string; this is the only definition of string. The next page uses PRINT to perform the arithmetical functions.

The fourth chapter is on "mistrakes" and shows how to correct them. Four pages on Shorthand are about scientific notation. The next section, on Boxes, is about storing numbers.

The first sentences of the book, on page 1, say "This book is about people, computers and a programming language called BASIC. We will communicate with a computer, in the BASIC language, about population problems." The second mention of population is on page 9, under Shorthand, showing how to print the population of the U. S. The third time is on page 15, under Division of Labor, which is about computing population in N years, based on initial population, growth rate, and number of years. With the section GO TO, starting on page 19, the reader learns how to make the computer perform this operation on successive groups of data. The section on Demography starts with a program that simply prints what is in the DATA statements, which is present population of the world's major regions, and their growth rates. On page 25, the reader is asked to write his first program, to compute the population in the year 2001 for each of these regions, ending with a grand total.

And so the book goes, enlarging on the population program. The World of IF section is on mathematical relationships, with a program that stops after computing the hundredth year of population growth. Race to Oblivion makes the program more general, inputting two populations and their growth rates, and computing the year in which one overtakes the other. In the example, the population of Latin America overtakes that of Europe in 1994. A section on Beware of Mathematical Models warns against making unwarranted assumptions that can lead to unreasonable computer results.

The section on Count to N is about FOR-TO and NEXT, and introduces a 16-country data base of populations and growth rates; the accompanying program only prints out the data directly, with headings, but without any computing. Subscripted Variables has a 22-line program, but uses the variables merely to print out the data directly, as is done with subroutines in the next section on Building Blocks. Information Retrieval picks population and growth rate from the data base, when the region number is entered. The text notes that it would be nice if the name of the region could be entered instead of its number, and goes on to say that this involves asking someone (or checking the reference manual) about strings.

Page 55 has a variation of the program illustrating subroutines: it asks for two region numbers, then computes when the population of one will overtake the other. Page 60 has a "things to do" section, which gives the same data base as before, but adds birth and death rates, then says "think up ways to use the data and write programs to do so."

Page 61 borrows an idea from Sack & Meadows (27), with a page on Janus, the god with two faces, who "looks backwards . . . and forwards." The text notes that "Now you can speak a little BASIC. But you aren't yet fluent. We have introduced only a primitive form of BASIC. . . ." and then, "This is the end of the beginning. Look ahead . . . and one more thing . . . please recycle this book."

Page 62 recommends the books by Coan (11) and Kemeny & Kurtz (2) "if you want to learn more about BASIC and you like math." For those whose math is "a little wobbly (or non-existent!)" the book by Sharpe & Jacob (17) is recommended.

The typography makes the book look grade-schoolish, but the language is often at senior high-school level.

There are exercises within each chapter, to be run on the computer.

In comparing these 64 pages with the 64 of the NCTM book (4), there is much too much space spent here on using the computer as a printer, and not enough on actual computation. The one-track population theme severely restricts the author to what would be terribly monotonous if the text were any longer. The young beginner deserves a better break.

This text was originally written for Digital Equipment Corp. as *Population: A Self-Teaching BASIC Primer,* copyrighted in 1972 and priced at $2.00. But before DEC published it, Dymax, as permitted by their contract, published a rewritten version, *My Computer Understands Me,* copyrighted in 1971. Dymax sold 25,000 copies in two years, according to the author.

The main difference in the DEC book is that it has none of the eye-catching headings in large gothic (and other) typefaces, decorative borders, pointing fingers, and a variety of ornaments, including huge quotation marks around don't-forget items (changed to "thought clouds" in the DEC version, as in comic books). DEC does keep the Kilroy head, except for the last one, a full page in the Dymax book, with a huge Kilroy admonishing the reader to "Experiment!!"

The DEC book adds a page on the Teletype keyboard, changes the section on E-notation considerably (with different examples), has a new section on PRINT, adds a chapter on Computer Power, goes into more detail on loops (with a more complex trace output), drops the whole sorcerer's apprentice bit (used to explain infinite loops), adds a program to demonstrate IF-THEN (tracing the program in detail), adds two pages explaining FOR and NEXT, etc.

Both books recommend, at the end, other books on BASIC. The DEC book also gives four sources of information on population, plus a list of DEC publications, under the heading "First, get help from your trustworthy computer supplier, DEC."

The DEC book is typewritten, using roman and italic type, and is much neater, without the flamboyance and flair of the Dymax book, and without the fun.

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29. *Elements of BASIC*, by R. Lewis and B. H. Blakeley. Copyright 1972, by National Computing Centre, Ltd., London, England. 83 pages, 12 x 8½, £1.80 UK (hardcover), $9.00 USA (International Publications Service, 114 E. 32 St., New York, N. Y. 10016).

Succinct and thorough, covers more BASIC than any other book its size. Rating: A

British teenagers are more sophisticated than their American counterparts, to judge from this text, whose introduction says that "In schools, teachers may find that the first four chapters can form the basis of a course for 13-16 year olds." Yet I found myself saying several times while reading, "Are they bringing this up already?" They are indeed, and with quite adequate preparation, providing the reader pays close attention, as there is a minimum of repetition.

Nine chapters make up the book: Introducing BASIC, Extending BASIC Statements, Character Handling, Loops and Arrays, Numerical Methods, Procedures and Subroutines, File Handling, Matrices, A Problem Miscellany.

The first chapter starts right out with a page each on flowcharts, the computer, and the program, and then goes into entering and running a program on a terminal.

At the end of each chapter is a summary of the main points, including the statements introduced. There are exercises within each chapter (without answers); three sets in Chapter 1, for a total of 20 exercises in that chapter. The first exercise is on converting a sum of money in pounds and pence into dollars and cents. The exercises soon grow quite sophisticated: one in the third chapter goes like this: "Write a program which prints out the day of the week for a particular date, given one day and date in the same month."

By page 25, there is no longer an explanation of the program except for the ever-present flowchart. Thus the reader is forced to learn to read and understand flowcharts if he wants to be able to understand the programs.

The book moves quickly to longer programs, and by page 33 has a 28-liner, which asks the user questions about his grades, and then comments on them.

This is one of ten books that introduce INPUT before DATA, perhaps to emphasize the interactive aspect of on-line time-sharing.

By page 35, the book notes that "The end of the data list is indicated by a dummy item, in this case, zero, which is used to terminate the program execution." Nobody else says that much about the dummy zero in just the one sentence.

By page 38, the authors are into an inventory-records program, by page 43 a program with triple loops, and on page 53, computing the area under a curve.

A neat simile is used to explain arrays: "For example, a milkman could note down the amount of milk required for each house in a street in an array such as (1, 6, 2, 3, 1, 0, 4 . . . .)."

Bubble-sorting is explained more thoroughly than most other subjects, with half a page devoted to showing the exact steps involved in sorting six numbers.

REM is mentioned on page 30, although it is never used, perhaps due to space limitations, although there is enough white space in the book to permit dozens of REM statements. On the other hand, statements within a loop are indented in the programs, but no reason is given.

Another terse item: "Thus, if we write Y = RND(X), Y takes on a value between 0 and 1. X can have any value. It is in fact a dummy number which may have some significance in some systems."

Chapter 7, on File Handling, refers to cards in a pocket at the back of the book, which show Filed Program Manipulation on nine different systems (6 US, 3 UK) and the same five programs as run on each; all are inventory programs, such as creating, updating, etc. It would seem to be much easier to put the material on these cards in an appendix.

The last chapter, A Problem Miscellany, contains advanced exercises in eleven areas, with several programs to be written for each. For banking procedures, programs are required for setting up accounts, deposit and withdrawal, money transfer, etc. The last exercise is to write a program for a guessing game such as Hangman. This is the only indication that the book is for schoolchildren.

The longest program is a 57-liner, to sort a list of names of people, first by height and then by weight, as an illustration of subroutines. All programs are in Teletype printout; nearly all are very legible, although a couple are somewhat faint. Nearly all should have been printed larger.

There are very few things that would give an American any difficulty in reading this book; most of the differences are easily understood. "Swop" is used where we would write "swap." One of the computer units is the "store." The decimal point is above the line. And although the text and flowcharts use the dollar sign for strings, the programs themselves use the pound sign; the text says one can use either. Only two items may puzzle the non-British: the gameboard for "snakes and ladders," and the exercise that requires calculating the average runs scored by all the batsmen in a cricket club, including the number of times "not out."

There is a mystery connected with this book: why did the authors (or publishers?) decide to use such an odd size, 12 inches wide and 8½ inches high? The book is printed two columns wide per page, and could easily have been made into a book half as wide, and thus much easier to handle. However, the wider book does stay open more easily.

This is a no-nonsense book, without any sign of the "gee-whiz" attitude found in some American books.

Some good advice on the practical side of programming is given in the last chapter: "The reader should not expect well defined programs and rarely is there any indication of the features of BASIC which should be used."

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30. *A Visual Approach to BASIC*, by Robert E. Smith. Pub. 1972, by Control Data Corp., Minneapolis, Minn., 278 pages, 7 x 10¼, $5.00 (paperback) invoiced, $4.75 cash.

Much too difficult for all but top minds. Rating: A for geniuses, D for the rest of us.

At first glance, this is a book for children. The opening line is "The Lady Cataswank Case really began the night Reggie Cataswank made his way down to Runnymede to seek the help of the Inspector." The drawings show people as caricatures, just as in some children's books.

By page eight, the reader begins to wonder if a child could understand the text, and by page 37 he knows that only a child in the top two percent of the class could. Page eight introduces the flowchart, but too much is presented, and too soon, to the reader who has no teacher to guide him, yet this is supposed to be "a self-instructional guide to computer programming." Page 37 has the first problem for the reader: write a program from a flowchart. Only the brightest reader could do this, with so little previous knowledge provided by the text. There is a difficult problem at the end of each chapter, with answers at the book's end.

The title is somewhat misleading. There are three types of figures in the book: programs, flowcharts, and drawings. Only the drawings are unique; they help tell seven stories, one per chapter. Each story is a "case" involving an inspector; the solution to each case requires a computer program. The author claims that "each unit emphasizes an interesting 'story-type' approach so that the reader is motivated to discover the outcome of each situation, as well as the corresponding programming concepts involved." Although this type of motivation is usually aimed at children, very few children could possibly write the program specified at the end of each chapter. For instance, the flowchart on page 104 requires a program that will, in part, sum the digits of a number. No hints are given on how to do this, which would be difficult for some experienced programmers; in most BASIC systems it has to be done the hard way, with a number of INT statements.

Smith seems to believe, and his previous book (10) lends further weight, that a reader learns much in trying to figure out a program already written, and without any REM statements. A great many readers will give up trying to solve the problem, and turn to the program in the back of the book. Whether or not they will learn anything from this depends on how good they are at digging, and how persistent.

This book could be used by a teacher, if he were to explain thoroughly and fill in with the required lead-in material, and not just aim at the top students in the class, which this text would facilitate. This might be a good book for good students who have already studied BASIC and who want a challenge.

Whether the book is for children or adults, there is no point in using "The Sinfoo Atrocity Case" to set up a problem, with public executions in both text and drawings.

Chapter 4 requires a program to help find eight chests of gold. A very complicated procedure eventually leads, after a dozen pages, to a comparatively simple formulation that is nevertheless not simple to program and which uses much computer time. A great deal of the book is taken up, not in teaching BASIC, but in problem-solving, in working through a number of complex problems to get to a program. The author has let his fascination for such problems obscure the main point.

The most incredible problem involves 25 pages on finding out on which day of the week a person was born, given the date. Those 25 pages could have been put to much better use.

If this book were for children, the author might continue the use of LET in the assignment statement beyond page 18, but he does not.

It may well be true that a story-type approach can motivate the reader to discover the outcome of each situation, buy why make the crux of the story so complex that only a high-IQ reader can get it? Recommended only for Mensa members and others in the top-IQ bracket.

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31. *BASIC, A Computer Programming Language, with Business and Management Applications,* by C. Carl Pegels. Pub. Jan. 15, 1973, by Holden-Day, San Francisco, Calif., 198 pages, 5¾ x 9, $6.95 (paperback).

A useful book, although so terse it's more of a summary of BASIC than a teaching text. Rating: B

The preface calls this a book "intended for those people who would like to be able to use computers to solve problems and help in making decisions – either immediately or some time in the future. Thus, it is written both for practitioners and for students." However, it seems to be more for a programmer than for a beginner, not only because page one says it is for "the programmer who wants to become proficient in programming" and it is "also intended as a reference for the occasional programmer." The author assumes a rather intelligent reader, because there are many sections where much is covered in only a few sentences, giving the book the flavor of a reference manual rather than a text. There is a minimum of the repetition used in many of the other BASIC books to reinforce the impressions made on the reader.

After a rough start, the book improves. This is an example of an author who presents the introductory material somewhat briefly (the first 38 pages) so he can devote most of the book to the applications. If the reader has been able to obtain a firm foundation in those 38 pages, it's much easier from there on, as the writing is better, and there are more explanations and more examples. After presenting a program, the author explains it in full detail.

The author tightens up again, however, for Chapter 6, on programming with data files, page 55. This chapter is written so succinctly, without full explanations and examples, that it would be very hard to understand except by an experienced programmer.

The first program is on page four, and consists of six lines, calculating the cost of a quart of milk. Most of the programs are between 10 and 15 lines long. Pegels is one of the few to go into FILES, and the only one to introduce it as early as page 55. Nearly all the authors assume the reader has some knowledge of vectors and matrices; Pegels includes an eight-page appendix on the subject.

There is a small error in the program on page 23, illustrating loops, that could easily confuse a beginner, who might not be able to figure out that line 150 should read LET X = X + I, rather than LET X = X + 1. So the answer to the program as written is 5 rather than 15. Such an error could cause a misconception on the use of loops that might last for many chapters, and perhaps never be fully dispelled.

There is an oddity on page 32, in a program concerning averages. The average weight of the twelve students is 160.5; the average height is 70.3. If the units are centimeters and kilos, the average student is 63 inches tall and weighs 156 pounds!

There are twelve chapters: Introduction; Elements of BASIC; Looping, Subscripted Variables and More About PRINT; Flowcharting; Functions, Subroutines, Input and String Variables; Programming With Data Files; Matrix Operations; and five chapters on applications, beginning on page 75 with a chapter on statistical problems, including means, deviations, and probabilities. Chapter 9, on business and economic problems, deals with payroll, depreciation, average and marginal cost, breakeven and compound interest. Chapter 10, on production management, covers order point and quantity, ratio scheduling, and learning curves. Chapter 11, on random numbers and simulation, involves simulating simple processes, a "junior merchant's problem simulation," and a queuing simulation. Chapter 12 on corporate financial models gives one program that is rather skimpy on explanations.

There are exercises at the end of each chapter, and complete solutions at the end of the book. The two appendixes are on vectors and matrices, and the teletypewriter terminal.

A unique feature is the presentation of two illustrative programs, on page 20, without explanation; the reader is asked to analyze them. This would be very difficult for a beginner, after only 20 pages, especially since neither program seems to have a practical use.

The text is so brief as to be puzzling in some places. The style is rather choppy.

An uneven book, and a compact one, better as a second book than as a first one for a beginner. The applications portion contains many (39) programs of a wide variety.

32. *BASIC,* by Robert L. Albrecht, LeRoy Finkel, and Jerald R. Brown. Pub. Feb. 9, 1973, John Wiley & Sons, New York, N. Y., 324 pages, 8½ x 11, $3.95 (paperback).

Obviously the result of much teaching of BASIC to young people. Every difficult point is nicely explained in full detail. Rating: A

One of a series of "self-teaching guides," this book says on its front cover, "Teach yourself the quick proven way with programmed instruction." Well, it's not quite programmed instruction. Rather, there are blanks to be filled in, with words or program lines, or even entire programs. Each chapter ends with an excellent "self-test," which also has blanks to be filled in, and is immediately followed by the answers in full, including programs and runs.

There are ten chapters: Getting Started, Warming Up, Decision Making, FOR-NEXT Loops, Functions, Subscripted Variables, Double Subscripts, Subroutines, Advanced BASIC, and Files. The book ends with a final self-test; all answers are given. completes the chapter.

The book proceeds quite simply and slowly, taking 41 pages to teach, in the first chapter, the use of SCRATCH, PRINT, END, RUN and LIST. The reader is slowly led into writing programs, and by page 51 is writing six-line ones. The authors go into greater detail than any others in teaching decision-making, subscripted variables, and DIM; there are 9 pages on inequalities. The section on string variables is detailed and fine.

The writing is informal and easy-going, at the high-school level, even though the preface suggests the book is suitable for college students and adults, who however might find the slow-but-sure method rather drawn-out.

There are very few criticisms of this book. A great deal of white space is used, especially at the bottom of pages; the book could have been several dozen pages shorter. The program on page 128 has data that couldn't possibly produce the computed result.

There are eight pages on statistics, going into variance and standard deviation. Although the text says the reader not familiar with statistics can skip over this section, it does seem out of place in a book so obviously written for high-school students, even though the statistics are used only to demonstrate subroutines. Two pages are used to describe the TYP function, as though it were common, yet Waite & Mather (1) is the only other book that mentions it.

There is a clever program to generate five-letter words with a random selection of letters.

This is the only book other than Dwyer & Kaufman (33) to include something on computer art: three programs provide simple patterns.

The authors use the idea of "little boxes inside the computer" to help teach storage of variables; Dwyer & Kaufman (33) use "mailboxes." Most authors rely on words alone to teach this.

New material sometimes appears in a self-test, but without explanation. On page 261, the reader is asked to write a sort program, without any previous information other than two little hints. As the authors put it, this is a "real programming challenge."

As for content: although only three dozen BASIC statements are covered (including six for files and four for matrices) those three dozen are covered in great detail, giving the reader a solid buildup.

* * *

33. *A Guided Tour of Computer Programming in BASIC,* by Thomas A. Dwyer and Michael S. Kaufman. Pub. July 3, 1973, by Houghton Mifflin, Boston, Mass., 156 pages, 8½ x 11, $3.60 (paperback).

The best of the introductory texts, bright and sparkling. Rating: A

The first thing you notice when opening this book is the engaging illustrations in red and black (by Mark Kelley), cheerful but not cute, 67 of them, adding a nice touch of sparkle to the words. The next feature that hits the eye is the many callouts to the programs, outlined in red, and with a red line pointing to the line or lines they explain. Computer-generated program lines are overprinted in red. These features, plus a text by authors who have given a great deal of thought to the necessary amount of detail required, make a most attractive book.

There are four parts. Getting Ready for the Journey covers the basics of LET, PRINT and END. The Economy Tour introduces six more statements. Techniques for the Seasoned Traveler, nine more statements plus library functions. Far Away Places presents nine applications programs. This book covers 20 statements, 3 commands, and the library functions.

The first part contains a unique section, on How to Recognize a Computer, with pictures and information on minis and "large machines." Page 9 slides neatly into an introduction of flowcharts by showing a "final checklist for time-sharing users." This book is meant to be used with a terminal; the sections in which the reader is asked to use the terminal are indicated by a repeated "ON-LINE" alongside, in red, and sideways.

Page 16 is a perfect model of what an Example of a Normal Session should look like (even grown-up readers would profit greatly from it), with all errors and corrections fully explained with boxed callouts and red-overprinted program lines.

There are several sets of exercises within each of the four parts, and at the end of the book are Selected Answers and Hints for Exercises. At the end of each section in each part is a review of the material covered.

Another excellent section teaches LET with a blackboard, mailboxes, and many examples; they've been used before, but this is the best so far. There is a unique section that compares looping with two different statements, IF-THEN and FOR-NEXT.

The book begins to get a little difficult at page 75, when the reader is asked to write a program that will create a bar graph.

The section on Storing Programs on Paper Tape is the best of all those seen, with several fine figures. The method of introducing subscripted variables is quite clever: an airline-seat reservation system.

The authors are the only ones to provide the proper pronunciation of subscripted variables, by noting that M(8) is pronounced "M sub 8." A map is cleverly used to teach two-dimensional arrays, by asking the reader to obtain statistics on the number of accidents at each intersection.

READ and DATA are not introduced until page 100, as an indication of the stress the authors put on interactive computing. There is a unique section on three ways to get your computer to provide a different random output every time.

Part 4 has five application areas with nine programs, for a hotel reservation system, airline reservation system, generating brand names for a soap, generating menus to choose dishes from in an automated restaurant, slot-machine game (cherries, lemons, oranges), buried-treasure game, monthly installment payments on a loan, same with interest only on the unpaid balance, and payroll.

The last page contains a summary of BASIC, with statements and commands, and for each its name, page where explained, purpose, and an example, more complete than in any other book.

There are few features on the debit side of the ledger. Most authors who wish to indicate that certain idiosyncracies are due to the particular time-sharing system being used, do so in a brief statement early in the book. Dwyer and Kaufman do it in the text, not once, but ten times.

There could be a little more explanation of how to declare array sizes using DIM, of the use of INT in rounding, and of the program for tabulating questionnaire data. There is no explanation at all of the bubble-type sorting program, nor of the buried-treasure program; each needs one.

The authors use both parentheses and brackets, as do Gross & Brainerd (22) but without explaining the difference in usage.

This is, then, a fine book, mainly for young people, but of value for anyone, full of detail, many examples, with much thought having been given to the use of graphics in teaching. This is the best of the introductory texts on BASIC.

* * *

34. *Principles of Data Processing,* by Robert A. Stern and Nancy R. Stern. Pub. Feb. 9, 1973, by John Wiley & Sons, New York, N. Y., 630 pages, 7¼ x 9¼, $12.95 (cloth).

Workbook for Principles of Data Processing, pub. Apr. 30, 1973, 325 pages, 8½ x 11, $5.50 (paper).

BASIC Supplement to accompany Principles of Data Processing, pub. Mar. 27, 1974, 131 pages, 8½ x 11, $4.50 (paper).

The main text and the workbook are excellent for learning all about the fundamentals of business programming, in great detail, and rate an A. However, the BASIC supplement, despite some fine portions, is not up to the same standard, and rates a C.

The main text, the Principles, is a handsome book, very well produced, with excellent use made of color, and with a great many fine illustrations (flowcharts, forms, photographs, card layouts).

There are 20 chapters in three sections. Section One is on fundamental concepts of data processing, with six chapters: overview, business organization and the role of the data-processing department, punched card and printed report, processing of data by computer, input/output devices, a guide to terminals and time-sharing. Section Two, on Concepts of Computer Programming, has nine chapters: steps in programming, flowcharting, introductions to COBOL, RPG, FORTRAN, PL/1, BASIC, software: control and optimization of computer capability, common programming techniques. Section Three, on Systems Analysis and Design, has five chapters: systems analysis, systems design, two case studies (accounts receivable, inventory system), and management information systems and other decision-making techniques.

The preface says that "this textbook differs significantly from the data processing texts currently in use. It introduces the concepts of data processing as they actually relate to the business world . . . . We do not attempt to idealize data processing." All very true.

At the end of the first chapter is a Self-Evaluating Quiz, with 16 completion-type and true-and-false questions, with the answers following immediately. There is such a quiz at the end of each chapter, and also in the middle of the longer chapters.

Chapter 2, on business organization, contains organization charts for retail and manufacturing companies to help illustrate "the flow of information within a typical company." Chapter 5, on input/output devices, looks into the card read/punch, printer, tape drives (and details such as labels, and file protection rings), disks, specialized equipment (such as MICR, OCR, paper tape, offline devices). An 8-page table compares the characteristics of 26 computers, from the Burroughs B3500 to the XDS Sigma 6. Chapter 8, on Program Flowcharting, has examples in inventory, banking, accounts receivable, and updating.

Chapter 9, Introduction to COBOL Programming, shows filled-in coding sheets, card formats, output tape format, flowcharts, and sample programs for payroll, accounts receivable, salesmen's commissions, and is 30 pages long. The chapter on RPG is similar, with the same three types of programs, 38 pages long. The chapter on FORTRAN has a payroll program, then compares FORTRAN with COBOL; 13 pages. Chapter 12, on PL/1, has the three programs; 20 pages. The 12-page BASIC chapter contains five illustrative programs of 5 to 10 lines (simple calculation, temperature conversion, weekly wages, transaction amount, monthly sales report).

Chapter 16 has a hefty title: The Interaction Between the Analyst and the Businessman: Systems Analysis, with information on the basic elements, collecting data, analysis of current system costs, and problem definition.

Chapter 18, a case study of accounts receivable, is in detail, with 18 illustrations of reports, memos, flowcharts, card formats, and disk layouts.

Chapter 20, on Management Information Systems and Other Decision-Making Techniques, contains brief examples of typical companies using MIS: Westinghouse, Boeing, Chemical Bank of New York, and sections on CPM and PERT charts, simulation, linear programming.

The book ends with a 44-page appendix on Numbering Systems and Their Significance in Computer Processing, with sections on binary, octal and hexadecimal numbers, and representation of characters in storage.

The *workbook* chapters parallel those of the main text, complementing them very well, providing excellent information, and asking many good questions. As the preface puts it, "The workbook . . . includes applications in specified business areas, designed as realistic illustrations of data processing applications and as a vehicle for classroom discussion."

"Each chapter is subdivided into the following topics: define the following terms, answer true or false, multiple choice, fill in the missing blanks, and applications. [The first chapter aks for 15 definitions, 20 true-or-false, 10 multiple-choice, and 20 fill-ins.] The emphasis, throughout the Workbook, is on . . . Applications. This section contains data processing forms and layouts to be completed by the student in an effort to familiarize him or her with professional standards in this area."

The Applications portion of Chapter 1 contains two articles from *Business Automation,* which one reads and then answers eleven essay-type questions. One question is, "Don't you think that the system described above is an invasion of privacy? Explain your answer." Chapter 2 follows the same scheme; the applications portion discusses the acquisition of a computer by a Long Island department store, and considers the operations and organizations of each department.

Subsequent applications sections look into applications (payroll, banking, sales, accounts receivable), evaluation of a computer set-up (Honeywell 3200), a mini-computer application, OCR, online application (law enforcement, Burroughs), credit cards, betting (Varian), inventory system (Honeywell), personnel, etc. Most of these are based on application reports from computer manufacturers.

The chapter on systems analysis has a section on "the interview technique for collecting data," complete with three dialogues.

So far the authors have done beautifully. But then we come to the *BASIC supplement,* which is one of four; the others are on COBOL, FORTRAN, and RPG. There is also an instructor's manual that includes answers to all workbook questions. These four language supplements, by some Procrustean device, are each 150 pages long, according to the back cover of the one on BASIC.

The preface notes that "The [supplement] is written in the style of a programmed-instruction text. Each unit is followed by a series of self-evaluating questions that test the student's understanding of the material presented . . Each question is followed by five asterisks (*****) which provide a signal that the solution follows. It is recommended that the student read each question, using a card or sheet to cover the solution."

"Each chapter is followed by a series of Review Questions and Problems for which solutions are not provided. These may be used as homework assignments or as the basis for classroom participation."

There are six chapters: Terminal Processing With the Use of BASIC, Essential Elements of a BASIC Program, Writing Simple Programs in BASIC, The PRINT Statement and Its Options, Loops and Arrays, Functions and Subroutines. This supplement covers 16 statements, 5 commands, and 11 predefined functions.

By page 4 there have already been five questions. Chapter 1 has eight groups of 42 questions in all. So a third of the first chapter is question-and-answer, a rather high percentage. Counting the Review Questions at the chapter's end, the percentage of Q&A is 39%. This reinforcement technique may appeal to many; others may prefer fewer questions and more teaching text. Also, the Q&A method used takes much space: on page 8, some 39 square inches are used to present only four Q&A.

The text continually tells of different ways that different types of terminals might handle a particular situation; this is done nicely, not so much as to be boring or confusing.

The actual BASIC text is only about 63 pages in length, less than half the 131 numbered pages.

There are 21 programs in the book, with very few runs. The first program is a two-liner that prints square roots. The next three programs expand on that, using INPUT, READ, and DATA. The fifth program is 11 linches long, on calculating salesmen's bonuses, and is explained thoroughly. The sixth program computes averages, and is one of the few with output. Most of the programs are 4 to 8 lines long; the 19th, which computes exam averages for five students, is 15 lines long. The last program is 21 lines long, demonstrates subroutines, has no RUN.

The explanation of user-defined functions is possibly the best in all these books. There is some nice detail in describing the technique of looping: "initialize a field . . ., test the value of that field . . ., modify that field . . ., return to the beginning of the sequence." This book contains the best (most explicit) explanation of incrementing a counter, as when taking an average. It is one of the most painstakingly thorough in explaining each new statement.

For some odd reason, the only terminal shown is a CRT model; no Teletype is shown. There is nothing on rounding, RANDOM, etc. A curious error is the period at the end of a PRINT line on page 60.

The biggest fault of the book, for some readers, will be the constant annoyance of questions and answers appearing so often. For instance, Chapter 4, on PRINT, has 1½ pages of text, then ½ page of Q&A, a page of text, 2 of Q&A, 1½ text, 2 Q&A, ½ text, 2 Q&A, 1½ text, 2 Q&A, 2 text, 1 Q&A, and a page of review questions. That's fine for the reader who likes constant reinforcement, but not for the reader who prefers to ask his own questions.

Each chapter begins with a page devoted to section headings, which wastes much space, especially the first page of Chapter 6, which has only eleven words and two numbers on it.

Certain important points are boxed, but so are a couple of programs in the first chapter, so there is no apparent overall scheme.

Although there are a number of partial programs in the book, to explain things such as STOP, there are all too few complete programs, and almost no runs.

* * *

Interactive Computing in BASIC, by Peter Sanderson. Pub. 1973 by the Butterworth Group, London, £4.00 (hardcover), £2.00 (paperback).

(Review copy requested but not received.)

* * *

Simplifield BASIC Programming: With Companion Problems, by Lisa and Judah Rosenblatt. Pub. June 1973 by Addison-Wesley, Reading, Mass., 313 pages, 6¼ x 9¼, $3.95 (paper).

This is one of several books not being reviewed here because they are much more oriented toward applications than toward the teaching of BASIC. This particular one, for instance, has 82 pages on BASIC, followed by 172 pages of applications in the fields of mathematics, business, social science, and calculus (and 51 pages of solutions). With two-thirds of the book being on applications, and especially since there isn't a single word about BASIC in those 172 pages, it seems to fit better into my next group review, which (God and the publishers willing) will cover books on applications of BASIC.

SPAN-O-VISION A FUTURE-SCANNING WONDER

by Craig Johnson and Tom Dietz

In order to utilize the crucial human element in programmed prognostication, it's necessary for humans to participate, namely you readers of *Creative*. We plan to do a Delphi computer study of the FUTURE OF COMPUTERS! So gear your imaginations and read on.

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Send to: Tom Dietz, Division of Environmental Studies, Univ. of California, Davis, CA 95616.

COMPUTERS FOR THE PEOPLE!

A full schedule of sessions on the second day of the National Computer Conference, Tuesday, June 8, will be devoted to the topic "Computers for the People." It will consist of the following papers, demonstrations, and panel sessions:

- Computer Power to the People — *Sema Marks*
- Survey of Public Attitudes Towards Computers — *David Ahl*
- The Computer in Fiction — *Surprise Guest!*
- Computer Cartoons — *Ron Anderson*
- Building Your Own Computer — *Steve Gray*
- What Do You Do With A Home Computer — *Ted Nelson*
- Graphics, Videodiscs, and the Personal Computer — *Alfred Bork*
- Computers in Museums — *Carol Kastner, Phil Underhill*
- "You Should Name It Fun Time" — *Bill Mayhew*
- Public Library Computing — *Harold Shair*
- Total Public Access — *Rusty Whitney*
- Store Front Computer Centers — *Jim Dunion*
- The Computer in School and Town — *Myron Congdon*

NCC is at the Colosseum, and the Hilton and Americana Hotels in New York City, June 7-10. It includes over 200 papers, exhibits, workshops, art exhibits, and also the Nat'l. Student Computer Fair. For admission information write 1976 NCC, AFIPS, 210 Summit Ave., Montvale, NJ 07645.

ART BOOK NOTICE

All subscribers who are current as of May-Jun 1976 will receive the book *Artist and Computer* by Ruth Leavitt (Ed.) as part of their subscription to *Creative Computing*. This book will replace both the May-Jun and Jul-Aug 1976 issues. We will resume in standard magazine format with the Sep-Oct 1976 issue.

Artist and Computer is printed on heavy, high-quality paper and has over 130 illustrations (color and b & w) which portray the works of 40 leading computer artists from Germany, Japan, France, Canada, England, and the USA. 128 pages, 8½ x 11, paperback, $6.95 plus 75¢ shipping in USA ($7.70 total), $1.75 shipping outside of USA ($8.70 total). Creative Computing Press, P.O. Box 789-M, Morristown, NJ 07960, USA. (Bookstore and dealer inquiries welcome.)

THERE'S MORE TO FREEDOM THAN SLOGANS

Everybody claims to be in favor of "freedom." Yet how many people really understand what it's all about? Consider the businessman who's all for free competition . . . unless his competition is named IBM or is Japanese. Or the mayor who wants plentiful transportation . . . but outlaws jitneys. Or the military leader who wants to defend freedom . . . using conscripted labor. Or the citizen who's all for free speech and press . . . so long as the material isn't "obscene." Each wants freedom for the things he considers important, but at the expense of somebody else's freedom.

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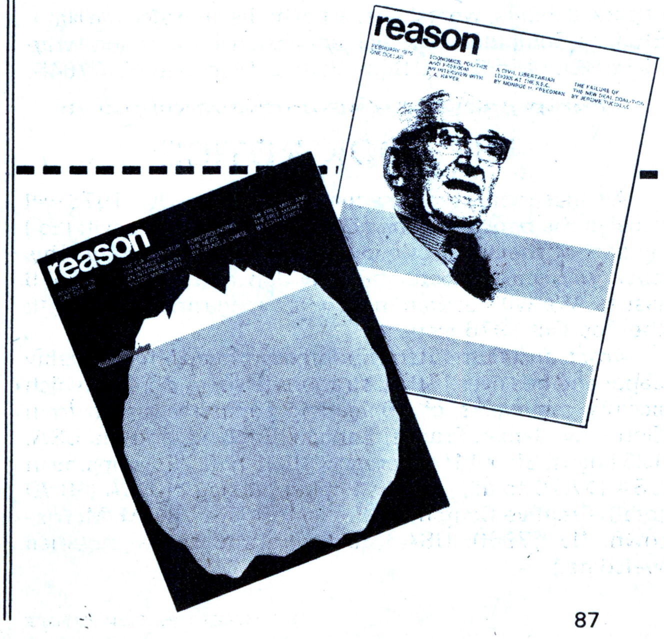
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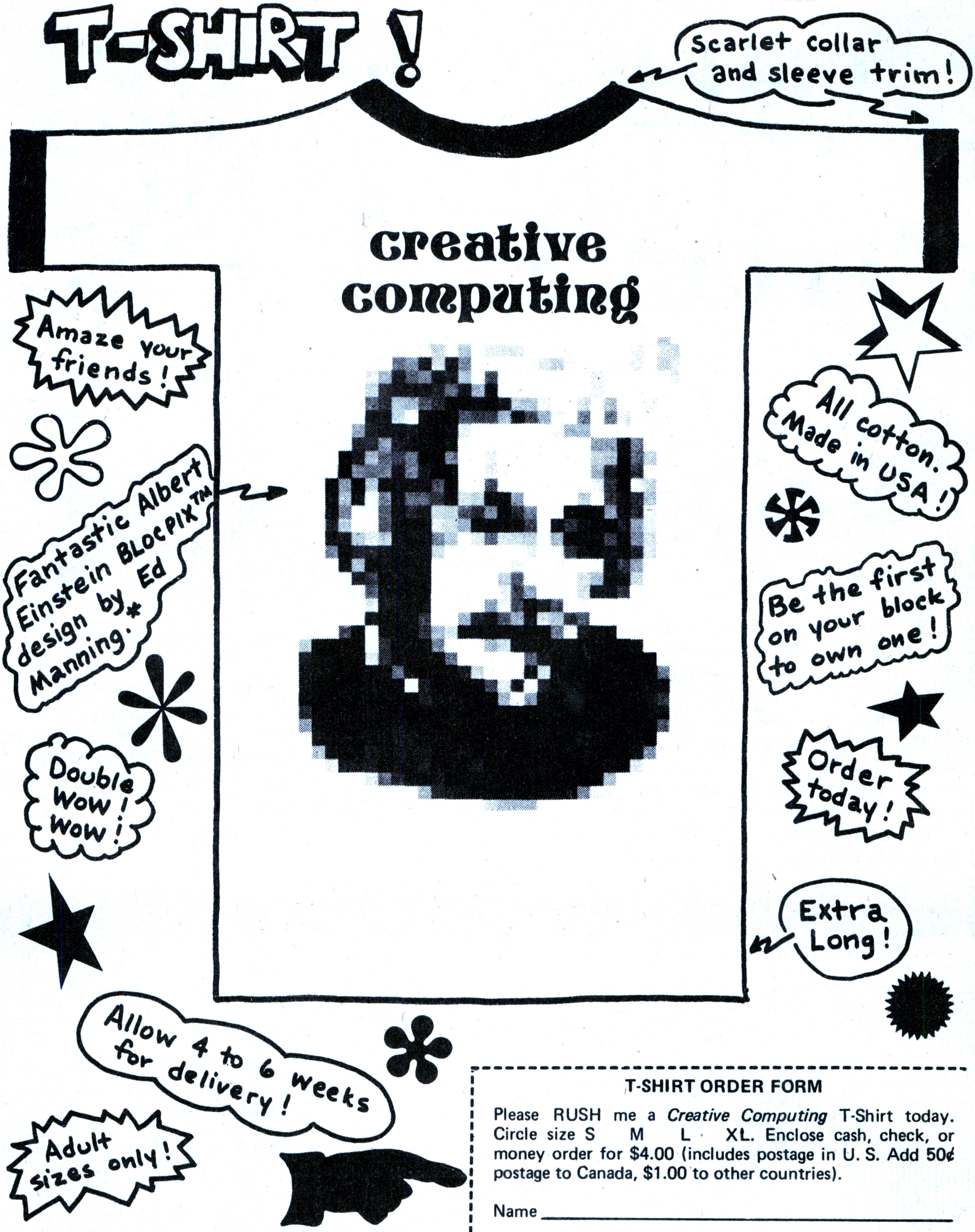
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Freeman Books for *Creative Computors*

THE THINKING COMPUTER
Mind Inside Matter
Bertram Raphael

The Director of the Stanford Research Institute's Artificial Intelligence Center has written this lucid and exciting introduction to contemporary artificial intelligence work. With a minimum of technical jargon, the book discusses the capabilities of modern digital computers, the goals and the progress of AI research, and the variety of approaches to making the computer more "intelligent." The tone throughout is informal: important concepts are developed through many specific examples from contemporary research and most of the book requires of the reader no mathematics beyond high-school algebra.

1976, 322 pp., 123 illus., Hardcover $12.95 A, Softcover $6.95 B

HOW TO SOLVE PROBLEMS
Elements of a Theory of Problems and Problem Solving
Wayne A. Wickelgren

The major purpose of this helpful book is to improve the reader's ability to solve all kinds of mathematical problems. Its secondary purpose is to present the elements of a theory of problem solving based on modern artificial intelligence work. Examples illustrating the methods are drawn from chess problems, logical puzzles, railroad switching problems, and from problems frequently encountered in science and engineering.

1974, 262 pp., 73 illus., Softcover $6.00 D

COMPUTER MODELS OF THOUGHT AND LANGUAGE
Edited by Roger C. Schank and Kenneth Mark Colby

"Several of the most important theoretical advances in language and memory that have been made in recent years are included in this book of readings. . . . A book that should appear on the shelves of every cognitive psychologist."—*The American Journal of Psychology*

CONTRIBUTORS: Robert P. Abelson. Joseph D. Becker. Kenneth Mark Colby. Earl Hunt. Robert K. Lindsay. Allen Newell. Roger C. Schank. R. F. Simmons. Yorick Wilks. Terry Winograd.

1973, 454 pp., 39 illus., Hardcover $14.50 F

COMPUTER POWER AND HUMAN REASON
From Judgment to Calculation
Joseph Weizenbaum

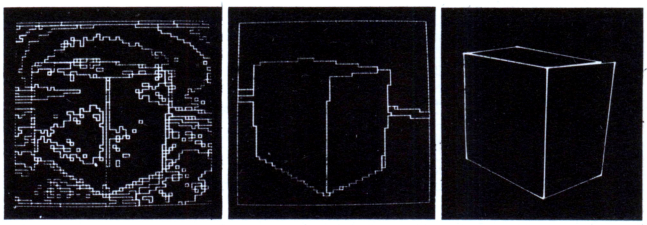
Computer Power and Human Reason is an account of the impact of scientific technology on man's self-image. It is a distinguished computer scientist's searching probe of the limits of computer power and of scientific rationality itself. Above all, it is an eloquent defense of the sanctity of the human spirit. Joseph Weizenbaum is Professor of Computer Science at MIT.

1976, 300 pp., 13 illus., Hardcover $9.95 C

EXPLORATIONS IN COGNITION
Donald A. Norman, David E. Rumelhart,
and the LNR Research Group

By combining the research skills and techniques of a variety of disciplines—psychology, linguistics, and artificial intelligence—the authors examine both the nature of the representation of knowledge within the human memory and the processes by which that knowledge is acquired and used. This book is a stimulating and comprehensive review of the authors' work of the past several years.

1975, 430 pp., 114 illus., Hardcover $13.50 E



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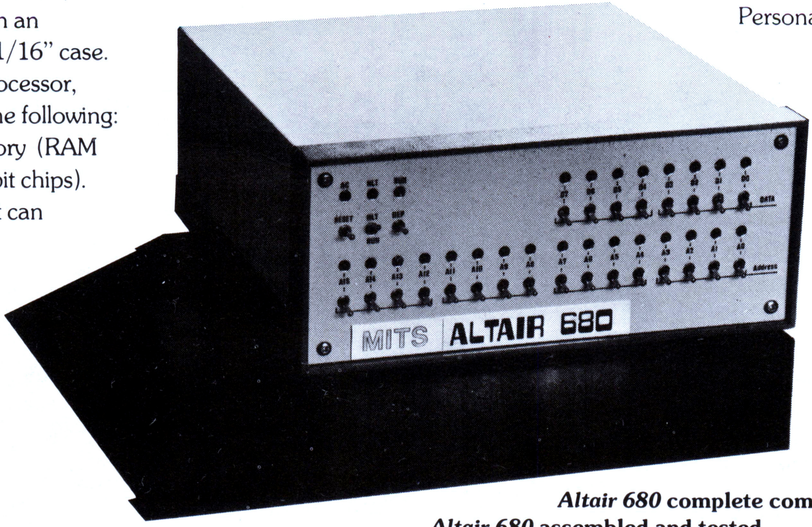

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Altair 680 Documentation

The *Altair 680* kit comes with complete documentation including assembly manual, assembly hints manual, operation manual, and theory manual. Assembled units come with operation and theory manuals. Turnkey model and CPU boards also include documentation.

NOTE: *A complete set of Altair 680 manuals in a 3-ring Altair binder is now available for $14.50 (regularly $25). Offer expires January 30, 1976.*

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